U. S. AIR FORCE INTEGRATED NATURAL RESOURCES MANAGEMENT PLAN

Tinker Air Force Base

Plan No. 32-7064

(See INRMP signature pages and Annual INRMP Review and Update Requirements for plan approval date)

ABOUT THIS PLAN

This installation-specific Environmental Management Plan (EMP) is based on the U.S. Air Force's (AF) standardized Integrated Natural Resources Management Plan (INRMP) template. This INRMP has been developed in cooperation with applicable stakeholders, which may include Sikes Act cooperating agencies and/or local equivalents, to document how natural resources will be managed. Non-U.S. territories will comply with applicable Final Governing Standards (FGS). Where applicable, external resources, including Air Force Instructions (AFIs); AF Playbooks; federal, state, local, FGS, biological opinion and permit requirements, are referenced.

Certain sections of this INRMP begin with standardized, AF-wide "common text" language that address AF and Department of Defense (DoD) policy and federal requirements. This common text language is restricted from editing to ensure that it remains standard throughout all plans. Immediately following the AF-wide common text sections are installation sections. The installation sections contain installation-specific content to address local and/or installation-specific requirements. Installation sections are unrestricted and are maintained and updated by AF environmental Installation Support Teams (ISTs) and/or installation personnel.

NOTE: The terms 'Natural Resources Manager', 'NRM' and 'NRM/POC' are used throughout this document to refer to the installation person responsible for the natural resources program, regardless of whether this person meets the qualifications within the definition of a natural resources management professional in DODI 4715.03.

TABLE OF CONTENTS

ABOUT THIS PLAN **2**

TABLE OF CONTENTS **3**

DOCUMENT CONTROL **6**

INRMP APPROVAL/SIGNATURE PAGES **7**

EXECUTIVE SUMMARY **10**

1.0 OVERVIEW AND SCOPE **12**
- **1.1 Purpose and Scope** **12**
- **1.2 Management Philosophy** **13**
- **1.3 Authority** **13**
- **1.4 Integration with Other Plans** **17**

2.0 INSTALLATION PROFILE **18**
- **2.1 Installation Overview** **19**
  - **2.1.1 Location and Area** 19
  - **2.1.2 Installation History** 21
  - **2.1.3 Military Missions** 23
  - **2.1.4 Surrounding Communities** 24
  - **2.1.5 Local and Regional Natural Areas** 25
- **2.2 Physical Environment** **26**
  - **2.2.1 Climate** 26
  - **2.2.2 Landforms/Physiography** 28
  - **2.2.3 Geology and Soils** 29
  - **2.2.4 Hydrology** 35
- **2.3 Ecosystems and the Biotic Environment** **41**
  - **2.3.1 Ecosystem Classification** 41
  - **2.3.2 Vegetation** 41
  - **2.3.3 Fish and Wildlife** 48
  - **2.3.4 Threatened and Endangered Species and Species of Concern** 58
  - **2.3.5 Wetlands and Floodplains** 63
  - **2.3.6 Other Natural Resource Information** 66
- **2.4 Mission Impacts on Natural Resources** **66**
  - **2.4.1 Natural Resource Constraints to Mission and Mission Planning** 66
  - **2.4.2 Land Use** 67
  - **2.4.3 Current Major Impacts** 67
  - **2.4.4 Potential Future Impacts** 69
  - **2.4.5 Natural Resources Needed to Support the Military Mission** 70

3.0 ENVIRONMENTAL MANAGEMENT SYSTEM **71**
- **Environmental Compliance Assessment and Management Program (ECAMP) Inspection** **71**

4.0 GENERAL ROLES AND RESPONSIBILITIES **72**

5.0 TRAINING **75**

6.0 RECORDKEEPING AND REPORTING **77**
- **6.1 Recordkeeping** **77**

6.2 Reporting **77**

7.0 NATURAL RESOURCES PROGRAM MANAGEMENT **78**
7.1 Fish and Wildlife Management **78**
7.2 Outdoor Recreation and Public Access to Natural Resources **97**
7.3 Conservation Law Enforcement **100**
7.4 Management of Threatened and Endangered Species, Species of Concern and Habitats **102**
7.5 Water Resource Protection **111**
7.6 Wetland Protection **115**
7.7 Grounds Maintenance **117**
7.8 Forest Management **123**
7.9 Wildland Fire Management **123**
7.10 Agricultural Outleasing **123**
7.11 Integrated Pest Management Program **124**
7.12 Bird/Wildlife Aircraft Strike Hazard (BASH) **134**
7.13 Coastal Zone and Marine Resources Management **139**
7.14 Cultural Resources Protection **139**
7.15 Public Outreach **139**
7.16 Geographic Information Systems (GIS) **140**

8.0 MANAGEMENT GOALS AND OBJECTIVES **141**

9.0 INRMP IMPLEMENTATION, UPDATE, AND REVISION PROCESS **147**
9.1 Natural Resources Management Staffing and Implementation **147**
9.2 Monitoring INRMP Implementation **148**
9.3 Annual INRMP Review and Update Requirements **148**

10.0 ANNUAL WORK PLANS **151**

11.0 REFERENCES **161**
11.1 Standard References (Applicable to all AF installations) **161**
11.2 Installation References **161**

12.0 ACRONYMS **168**
12.1 Standard Acronyms (Applicable to all AF installations) **168**
12.2 Installation Acronyms **168**

13.0 DEFINITIONS **171**
13.1 Standard Definitions (Applicable to all AF installations) **171**
13.2 Installation Definitions **171**

14.0 APPENDICES **171**
Appendix A: Annotated Summary of Key Legislation Related to Design/Implementation of the INRMP **171**
Appendix B: Natural Resources Annual Report **171**
Appendix C: Flora List **171**
Appendix D: Fauna List **171**
Appendix E: Native Landscaping Plant Material List **171**
Appendix F: Mitigation Action Tracker **172**
Appendix G: Urban Forestry Management Procedures **171**
Appendix H: Natural Resources Cooperative Agreements/Memorandums **172**
Appendix I: Species at Risk **172**

Appendix J: Natural Resources Equipment and Supply Inventory 172

15.0 ASSOCIATED PLANS (Tabs 1, 2, and 3 are attached as separate documents. Refer to OPRs for other plans) 172

Tab 1 – Green Infrastructure (GI) Plan 172

Tab 2 – Golf Course Environmental Management (GEM) Plan 172

Tab 3 – Wildland Fire Management Plan (WFMP) 172

Tab 4 – Bird/Wildlife Aircraft Strike Hazard (BASH) Plan 172

Tab 5 – Integrated Pest Management Plan (IPMP) 172

Tab 6 – Integrated Cultural Resources Management Plan (ICRMP) 172

Tab 7 – Storm Water Management Plan 172

Tab 8 – Climate Change Supporting Information 172

DOCUMENT CONTROL

Record of Review – The INRMP is updated not less than annually, or as changes to natural resource management and conservation practices occur, including those driven by changes in applicable regulations. In accordance with (IAW) the Sikes Act and AFI 32-7064, *Natural Resources Management*, the INRMP is required to be reviewed for operation and effect not less than every five years. Annual reviews and updates are accomplished by the base Natural Resources Manager (NRM), and/or an Installation Support Team Natural Resources Media Manager. The installation shall establish and maintain regular communications with the appropriate federal and state agencies. At a minimum, the installation NRM (with assistance as appropriate from the NR Media Manager) conducts an annual review of the INRMP in coordination with internal stakeholders and local representatives of the United States Fish and Wildlife Service (USFWS), state fish and wildlife agency, and National Oceanic and Atmospheric Administration (NOAA) Fisheries, where applicable, and accomplishes pertinent updates. Installations will document the findings of the annual review in an Annual INRMP Review Summary. By signing the Annual INRMP Review Summary, the collaborating agency representative asserts concurrence with the findings. Any agreed updates are then made to the document, at a minimum updating the work plans.

INRMP APPROVAL/SIGNATURE PAGES

Coordination
(Oklahoma Department of Wildlife Conservation)

The signatory below indicates Oklahoma Department of Wildlife Conservation coordination for the Tinker Air Force Base Integrated Natural Resources Management Plan.

Having reviewed the Tinker Air Force Base Integrated Natural Resources Management Plan, I hereby agree with those aspects of the Plan that are within the jurisdictional authority of my agency concerning conservation, protection, and management of fish and wildlife resources.

J.D. STRONG
Director, Oklahoma Department of Wildlife Conservation

11·8·2018
Date

Coordination
(Tinker Air Force Base)

The signatory below indicates Tinker Air Force Base coordination/approval for the Tinker Air Force Base Integrated Natural Resources Management Plan.

3 JAN 19

KENYON K. BELL, Colonel, USAF
Commander, 72d Air Base Wing

Date

Coordination
(U.S. Fish and Wildlife Service)

The signatory below indicates U.S. Fish and Wildlife Service coordination for the Tinker Air Force Base Integrated Natural Resources Management Plan.

Having reviewed the Tinker Air Force Base Integrated Natural Resources Management Plan, I hereby agree with those aspects of the Plan that are within the jurisdictional authority of my agency concerning conservation, protection, and management of fish and wildlife resources.

Amy Lueders
Southwest Regional Director
U.S. Fish and Wildlife Service

March 15, 2015
Date

EXECUTIVE SUMMARY

Tinker Air Force Base (AFB), home of the Oklahoma City Air Logistics Complex (OC-ALC), is located in central Oklahoma five miles southeast of downtown Oklahoma City in the heart of the Sooner State, and is one of the largest and most important military installations in the United States. The largest single-site employer in the state of Oklahoma, Tinker AFB has an approximate workforce of 26,296 (16,307 civilian workers, 7,595 military personnel, and 2,394 contractor employees).

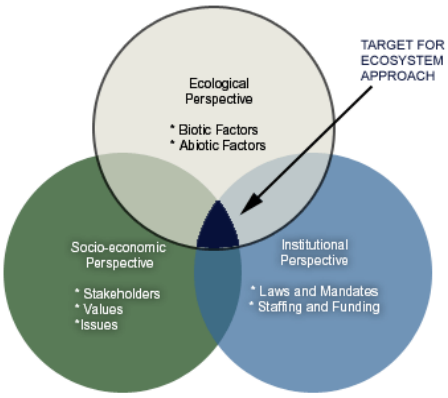
Tinker AFB is also home of the 552nd Air Control Wing, 507th Air Refueling Wing, 513th Air Control Group, the U.S. Navy's Strategic Communications Wing One, the Defense Logistics Agency's Defense Distribution Depot Oklahoma City, 38th Cyberspace Engineering Installation Group, and Defense Mega-center Oklahoma City.

Tinker AFB covers approximately 5,580 acres of land. Structures include a 10,000-foot runway, 11,200-foot runway, almost 700 family housing units, 48 miles of road, 717 buildings, and 57 aircraft assigned to associate units. The annual air traffic control traffic count (arrivals, departures, and practice approaches) is 34,000 to 36,000 and the annual ground traffic (aircraft and vehicle operations) is approximately 20,000.

The Tinker AFB Integrated Natural Resources Management Plan (INRMP) implements requirements of the Sikes Act; Department of Defense Instruction (DODI) 4715.03, Natural Resources Conservation Program; Air Force Policy Directive (AFPD) 32-70, Environmental Quality; and Air Force Instruction (AFI) 32-7064, Integrated Natural Resources Management in concert with the Tinker AFB Installation Development Plan (IDP).

The plan discusses the mission, vision, goals, and objectives for managing natural resources [i.e., flora (plants), fauna (fish/wildlife), soil, and water] in Tinker's urban ecosystem for the betterment of the warfighter, surrounding community, and environment. Included are discussions of the history, current condition, trend, and use of these resources and a detailed conservation strategy.

The plan strives to safely integrate all aspects of natural resources management with Tinker's flying mission. This is accomplished using an ecosystem management approach (i.e., integration of ecological, socio-economic, and institutional perspectives toward responsible and sustainable use of natural resources, Leslie et al., 1996) (see figure, "Ecosystem Management Approach").



Ecosystem Management Approach: Effective ecosystem management lies at the intersection of all three circles, taking into account ecological, socio-economic, and institutional (i.e., military mission) considerations.

This INRMP is intended to transform Tinker's natural environment to strengthen the military, their families, and the local community. It strives for positive change, using scientific fact to challenge old ways of doing environmental business. Many new policies have been established herein to facilitate and ensure going to the next level. The Plan is aimed at instilling pride and ownership in the surrounding natural environment by encouraging on- and off-base community involvement in the program. It promotes a balance between the needed facilities, roads, and runways and the natural environment. It brings competing interests together into a sensible approach to managing the heavily industrialized environment, leading to a greener, more vibrant, more livable community. This Plan aims to greatly improve Tinker's image and significantly contribute to the health, wellness, and quality of life of the workforce. It will move the health of installation's natural environment forward to better support and sustain military operational needs and expeditionary combat capability.

1.0 OVERVIEW AND SCOPE

This INRMP was developed to provide for effective management and protection of natural resources. It summarizes the natural resources present on the installation and outlines strategies to adequately manage those resources. Natural resources are valuable assets of the United States Air Force. They provide the natural infrastructure needed for testing weapons and technology, as well as for training military personnel for deployment. Sound management of natural resources increases the effectiveness of Air Force adaptability in all environments. The Air Force has stewardship responsibility over the physical lands on which installations are located to ensure all natural resources are properly conserved, protected, and used in sustainable ways. The primary objective of the Air Force natural resources program is to sustain, restore and modernize natural infrastructure to ensure operational capability and no net loss in the capability of AF lands to support the military mission of the installation. The plan outlines and assigns responsibilities for the management of natural resources, discusses related concerns, and provides program management elements that will help to maintain or improve the natural resources within the context of the installation's mission. The INRMP is intended for use by all installation personnel. The Sikes Act is the legal driver for the INRMP.

1.1 Purpose and Scope

The purpose of this plan is to establish an organized and systematic approach to improve the overall health of Tinker's urban ecosystem within the context of the military mission. The plan includes a prioritized and measurable strategy that will guide natural resources conservation and military activities to ensure integration and consistency with federal mandates for ecosystem stewardship. Monitoring and adaptive management will be employed to ensure positive progress toward program goals and objectives. This will ultimately provide optimal military operational sustainability while promoting societal, economical, and ecological benefits for Tinker AFB and its neighboring communities in concert with the desired development pattern of the Tinker AFB Installation Development Plan.

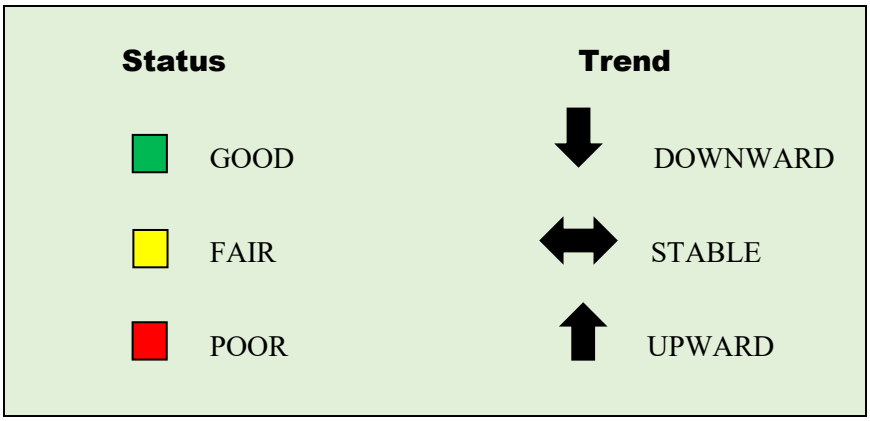
In 2003, natural resources program staff held a series of stakeholder meetings involving key personnel from Tinker AFB tenant organizations, local communities, private companies, and county, state, and federal governments. During the course of these meetings, two program deficiencies became evident: 1) inadequate planning in several resource areas, and 2) the natural resources program was moving forward without a clear understanding of its customers' needs and desires. Planning deficiencies included such things as the lack of environmental area master plans (such as urban greenways); area management plans (e.g., tree farm and urban forest); identification of targets or standards (e.g., pond water quality); inadequate overall reporting, tracking, and monitoring systems; and the need to ensure the INRMP is tied to plans of communities adjacent to Tinker AFB.

This plan is intended to correct these deficiencies through a more aggressive, proactive, holistic, and customer-focused conservation strategy. The planning aspects of the INRMP are more organized and detailed and include many new policy statements essential to sustainable natural resources improvements. The science-based strategy aims to ensure management actions are based in fact and not supposition. Furthermore, it aims to better measure actual progress and success in achieving natural resources goals, priorities, and mandates; stronger performance measures (metrics) have been integrated to evaluate program activities.

The INRMP applies to all lands managed by Tinker AFB including all leased areas (Glenwood, Landfill 6 Area, Military Family Housing) and other satellite areas to include, but not limited to, the Cyber Engineering Installation Group, Gator Site, and Fuel Control Facility. Efforts are underway, as applicable

and practicable, to work cooperatively with adjacent landowners to apply the INRMP scope beyond Tinker AFB boundaries.

Natural resources found within Tinker's urban ecosystem and addressed in this plan include flora (plants), fauna (fish and wildlife), soil, and water, and include a discussion of the vital connection between people and Tinker's natural resources, and lastly a brief discussion of important aspects of program management. Natural resources are described in their historical context, their present status (i.e., rated as POOR, FAIR, or GOOD), and trend (i.e., rated as DOWNWARD, STABLE, or UPWARD).



Natural Resources Current Status and Trend

1.2 Management Philosophy

For their roles and sacrifices in defending our nation, every airman and his or her family deserve the best standard of living—world-class facilities in a world-class environment. Moreover, as a federal agency, Tinker AFB should set the standard for managing land and associated natural resources within existing industrialized and urbanized landscapes. Therefore, it is our aim to be the model of a productive built environment. This is not possible without a balanced approach to military build-out and natural resources stewardship.

The INRMP establishes a comprehensive, interdisciplinary vision to achieve this balance and reach this standard. It sets forth goals and objectives framed by natural resources inventories, user surveys, science-based ecosystem management principles, and sustainability guidelines intertwined with our national defense needs to attain a healthy natural infrastructure that supports military mission goals.

1.3 Authority

The Sikes Act, 16 USC 670a, requires an INRMP be written and implemented for all DoD installations having significant natural resources. This plan has been developed cooperatively between the installation, the United States Fish and Wildlife Service (USFWS), and the Oklahoma Department of Wildlife Conservation (ODWC). The Air Force natural resources program ensures continued access to land, air, and water resources to conduct realistic military training and testing, as well as to sustain the long-term ecological integrity of the resource base.

This INRMP is developed under, and proposes actions in accordance with, applicable DoD and United States Air Force (USAF) policies, directives, and instructions including DoD Instruction 4715.03, *Natural*

Resources Conservation Program; AFPD 32-70, *Environmental Quality*; AFI 32-7064, *Integrated Natural Resources Management*; AFI 32-7065, *Cultural Resources Management*; legislation, executive orders (EO), and presidential memorandums. DoD Instruction 4715.03 provides direction for DoD installations to establish procedures for an integrated program for multiple-use management of natural resources. AFPD 32-70 discusses general environmental quality issues, including proper cleanup of polluted sites, compliance with applicable regulations, conservation of natural resources, and pollution prevention. AFIs 32-7064 and 32-7065 provide guidance on the preservation of natural and cultural resources, respectively, at USAF installations. The 'Annotated Summary of Key Legislation Related to Design and Implementation of the INRMP' table, included as an appendix to this plan, summarizes key legislation and guidance used to create and implement this INRMP. Refer to the complete listing of AFIs, the Federal Registry and the US Code to ensure that all applicable guidance documents, laws and regulations are reviewed. Installation-specific policies, including state and local laws and regulations are summarized in the table below.

Installation-Specific Policies (including State and/or Local Laws and Regulations)	
Green Infrastructure	**Policy 1:** Encourage sustainable development and military operational support by balancing gray infrastructure development with green infrastructure enhancement, restoration, and preservation. [Note: Designers of facilities in evaluation areas or near regulated areas shall consult Tinker natural resources staff early in the design process to evaluate and determine how the project may be designed consistent with principles outlined in this Plan. Within these evaluation areas, if impacts to green infrastructure cannot be avoided, they should be minimized. If minimization is not possible, the designer shall provide mitigation alternatives for consideration]. **Policy 2:** Tinker AFB shall observe a "no net loss of floodplain capacity" policy. Tinker will ensure no increase in the 500-year floodplain boundaries using the 2002 U.S. Army Corps of Engineers Tinker AFB Floodplain Study as the baseline. **Policy 3:** In developing future facility plans and as opportunities arise, all facilities located within the 500-year floodplain should be relocated to areas outside the 500-year floodplain. **Policy 4:** Employ conservation management principles when developing areas: • Practice compact development to the maximum extent practicable. • Focus on designing projects to "fit" the existing landscape or natural community as opposed to designing projects which require clearing and leveling the entire site and subsequently attempting to rebuild the landscape. **Policy 5:** Excluding the airfield, restore and maintain network gaps to create natural corridor connectivity wherever possible throughout the GI network. It is desired that these gaps be converted to native grasslands/woodlands a minimum of 300 feet wide (e.g., 150 feet on each side of a creek/trail) where practicable. In developed areas, any width of natural connectivity is encouraged. Where contiguous connectivity is not possible, the following guidelines shall apply: • Develop smaller natural areas (i.e., patches) which serve as stepping stones for wildlife movement. • Decrease distance between stepping stones wherever possible. • Emphasize larger patches over smaller ones. • Prioritize restoration by focusing first on higher order.

	streams versus lower order streams and gaps away from roads as opposed to close to roads.
Urban Forestry	**Tree Selection** **Policy 1:** In accordance with *Presidential Memorandum, Environmentally and Economically Beneficial Practices on Federal Landscaped Grounds,"* April 26, 1994, all trees planted on Tinker shall be native and in accordance with the Tinker AFB Native Tree List. Variances may be granted by the natural resources office under certain circumstances. **Tree Planting/Removal** **Policy 1:** A tree planting/removal permit must be obtained from 72 ABW/CEIEC prior to the planting or removing of any tree on Tinker AFB. **Policy 2:** A digging permit must be obtained from Civil Engineering prior to planting any tree on Tinker AFB. **Policy 3:** For every live urban tree removed on base, two trees (each of which will grow to at least the mature size of the removed tree) shall be planted within the urban forest management unit of the removed tree to offset the loss. Trees may be planted in other management units as determined by the base urban forester. Replacement trees shall not exceed a 1.5 inch trunk caliper. Seedlings of an equivalent value may be substituted at the government's discretion. **Tree Maintenance** **Policy 1:** Trees on Tinker AFB shall not be pruned by any government or contractor personnel except those who have received annual training through the base natural resources office or other tree care training approved by 72 ABW/CEIEC. **Tree (General)** **Policy 1:** All trees planted on Tinker AFB shall be planted and maintained in accordance with Tinker's Urban Forestry Management Procedures. **Policy 2:** Notably significant trees (e.g., 100-year-old oaks) shall be protected to the maximum extent practicable.
Fish and Wildlife	**Oklahoma Administrative Code 800:25-7-8:** Oklahoma Department of Wildlife Conservation regulations make it unlawful to kill, capture, keep as pets, or sell Texas horned lizards (THL). **Oklahoma Administrative Code 800:20-1-2:** Aquatic nuisance species on Tinker AFB are governed by state regulations. **Oklahoma Administrative Codes 29 and 800:** Tinker hunting and fishing are governed by state regulations established by the Oklahoma Wildlife Conservation Commission.

Fish and Wildlife (continued)

FISHING PERMIT PROCLAMATION & GUIDE
(TINKER AIR FORCE BASE)

Fishing information and permits are available online at "tinker.isportsman.net"

Fishing Permit Sales Structure

		Expiration Date
Annual Family	$20.00	31 Dec of issued yr
Annual Individual	$15.00	31 Dec of issued yr
7-day Individual	$ 10.00	7 days from issue
Seasonal Individual Trout Stamp	$ 15.00	seasonal yr issued
Family Trout Stamp	$ 20.00	seasonal yr issued

Bluegill
Lepomis macrochirus

GETTING YOUR PERMIT

1) Go to "tinker.isportsman.net" - mobile device or PC
2) Click on register tab, complete info and hit "save"
3) Click "Acquire Permits" button and selected permit "Add to Cart"
4) Enter State Fishing License number and "Checkout"
5) Bookmark page or print out permit from "My Account" tab

LICENSE/PERMIT REQUIREMENTS:

1. *A valid **State of Oklahoma** fishing license is required to fish in the Base ponds unless exempt (must show proof of license or exemption upon purchase of base permits).*
2. *Individuals exempt from Base permits include:*
   - *anyone exempt for an Oklahoma fishing license*
   - *youth under 16*
   - *handicapped individ., volunteers and participants taking part in a Aquatic Education Event*
3. *No **State of Oklahoma** trout stamp is required to fish for trout on Base.*
4. *Youth under 16 are exempt from Base Seasonal Trout Stamps.*
5. ***Annual Permits** - are required for fishing on base in ponds and streams, valid for the calendar year in which they are purchased (i.e., expire on Dec 31st of the year they are purchased).*
6. ***Seasonal Trout Stamps** - are required in addition to base annual permits, for anglers fishing in Redbud and Beaver Ponds from Veterans Day through the end of the trout season (31st Mar) must possess a Trout Stamp. Only one Trout Stamp is required per family with the purchase of an Annual Family Permit. Trout Stamps are valid for the entire trout season (Veterans Day—March 31st of the subsequent year). Only one pole in water per angler for trout fishing.*
7. *Family permits are valid for immediate family members only (i.e., spouses and dependent children, grandparents and grandchildren).*
8. *Permits are non-transferable.*
9. *The **7-day Individual permit** is good for seven consecutive days from the date of purchase.*
10. *No licenses or permits will be required during "Free Fishing Days" (in June).*

Channel catfish
Ictalurus punctatus

For Questions Contact:
72 ABW/CEIEC
Natural Resources
(405) 739-7065

NATURAL RESOURCES
TINKER AIR FORCE BASE

Largemouth bass
Micropterus salmoides

1.4 Integration with Other Plans

INRMP revisions and concurrence with the final plan is coordinated through the installation chain of command and internal stakeholders to include, but not limited to:

- AFSC/LG
- OC-ALC
- 552 AWACS
- Navy
- 507th/513th
- 38 CEIG
- 72 ABW/JA
- 72 ABW/PA
- 72 ABW/SE
- 72 MSG
- 72 FSS
- 72 OSS
- 72 SFS
- 72 ABW/CE
- AFCEC/CZO

The NRM ensures that the INRMP and the following base plans/documents are mutually supportive and do not conflict:

- Installation Development Plan (IDP)
- Integrated Cultural Resources Management Plan (ICRMP)
- Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and Resource Conservation and Recovery Act (RCRA) cleanup plans
- Bird/Wildlife Aircraft Strike Hazard (BASH) Plan
- Integrated Pest Management Plan (IPMP)
- Green Infrastructure Plan (GI)
- Golf Course Environmental Management (GEM)
- Wildland Fire Management Plan (WFMP)
- Air Installation Compatible Use Zone (AICUZ) study
- Joint Land Use Study (JLUS)
- Grounds maintenance contract

2.0 INSTALLATION PROFILE

Office of Primary Responsibility	72 ABW/CEIEC has overall responsibility for implementing the Natural Resources Management program and is the lead organization for monitoring compliance with applicable federal, state, and local regulations.
Natural Resources Manager/POC	John Krupovage (405) 739-7074
State and/or local regulatory POCs	Sikes Act-cooperating agencies for Tinker AFB are: **U.S. Fish & Wildlife Service** Amy Lueders, Director US Fish and Wildlife Service, Region 2 Albuquerque, NM Larry Levesque Oklahoma Ecological Field Services Office US Fish and Wildlife Service Tulsa, OK **Oklahoma Department of Wildlife Conservation** JD Strong, Director Oklahoma Department of Wildlife Conservation Oklahoma City, OK Mark Howery, Biologist Oklahoma Department of Wildlife Conservation Oklahoma City, OK
Total acreage managed by installation	5,580 acres
Total acreage of wetlands	56.2 acres
Total acreage of forested land	234 acres
Does installation have any Biological Opinions? (If yes, list title and date, and identify where they are maintained)	No
NR Program Applicability (Place a checkmark next to each program that must be implemented at the installation. Document applicability and current management practices in Section 7.0)	☑ Invasive species ☑ Wetlands Protection Program ☑ Grounds Maintenance Contract/SOW ☐ Forest Management Program ☑ Urban Forestry Management Program ☑ Grassland/Woodland Management Program ☑ Wildland Fire Management Program ☑ Agricultural Outleasing Program ☑ Integrated Pest Management Program ☑ Bird/Wildlife Aircraft Strike Hazard (BASH) Program ☐ Coastal Zones/Marine Resources Management Program ☑ Cultural Resources Management Program

2.1 Installation Overview

2.1.1 Location and Area

Tinker Air Force Base (AFB), home of the Oklahoma City Air Logistics Complex (OC-ALC), is located in central Oklahoma five miles southeast of downtown Oklahoma City in the heart of the Sooner State. (See Figure "Tinker AFB Location [State]"). The largest single-site employer in the state of Oklahoma, Tinker AFB has an approximate workforce of 26,296 (16,307 civilian workers, 7,595 military personnel, and 2,394 contractor employees).

Tinker AFB is also home of the 552nd Air Control Wing, 507th Air Refueling Wing, 513th Air Control Group, the U.S. Navy's Strategic Communications Wing One, the Defense Logistics Agency's Defense Distribution Depot Oklahoma City, 38th Cyberspace Engineering Installation Group, and Defense Mega-center Oklahoma City.

Tinker AFB covers approximately 5,580 acres of land. Structures include a 10,000-foot runway, 11,200-foot runway, almost 700 family housing units, 48 miles of road, 717 buildings, and 57 aircraft assigned to associate units. The annual air traffic control traffic count (arrivals, departures, and practice approaches) is 34,000 to 36,000 and the annual ground traffic (aircraft and vehicle operations) is approximately 20,000.

Tinker AFB Location (State)

Installation/Geographically Separated Units (GSU) Location and Area Descriptions				
Base/GSU Name	**Main Use/Mission**	**Acreage**	**Addressed in INRMP?**	**Describe NR Implications**
Tinker AFB (main body of installation)	Providing worldwide technical logistics support to Air Force aerospace weapon systems, equipment, and commodity items.	5,580	All Tinker AFB land areas (i.e., main body and GSUs) are classified as Category II and are managed under the INRMP. In the INRMP, management of natural resources on GSUs is not addressed separately from the main body of the base.	Most management of fish and wildlife, agricultural land, urban forest, wetlands, floodplains, invasive species, etc., is focused on this portion of the base.
Cyber Engineering Installation Group	Strategic planning, operational engineering, and implementation of cyber infrastructure.	130		Some small-scale management of wildlife, agricultural land, urban forest, invasive species, etc., is done on this land area. Western side of site is Landfill 6.
Gator Site	Miscellaneous military exercises	16		No significant natural resources on site
Consolidated Fuels Facility	Supports the test and calibration of fuel system components for aircraft airframes and engines	13		Some urban forestry management on this site, otherwise, no significant natural resources on site.
Glenwood Training Annex	Airfield Clear Zone (CZ), Accident Potential Zone (APZ), miscellaneous military exercises	280		Site is located off end of runway and therefore is managed to reduce BASH. Wetlands have been removed from the site in support of BASH program. This site is home to the base's largest deer population.
Maintenance, Repair, and Overhaul Technology Center (MROTC)	Aircraft modification	37		A portion of the site is in the 100-year floodplain, otherwise no significant natural resources on site.
Twaddle Reserve Center	Air Force, Marine, and Navy administrative space	25		No significant natural resources on site

2.1.2 Installation History

In October 1940, as German troops invaded Europe and Japan expanded its empire, a dozen Oklahoma City businessmen formed the Industries Foundation to attract a bomber base, an aircraft plant, or an air repair depot to the area. Their efforts proved successful when the War Department announced, on April 8, 1941, Oklahoma City as the site of a new air materiel depot that would cover more than 1,500 acres and employ 3,500 people. Construction on the new Midwest Air Depot began on July 18, 1941. Since the airfield was not ready for occupancy until March 1, 1942, official depot operations began in a downtown office building on January 15, 1942. Just eight days later, Oklahoma citizens learned that the Army Air Forces had decided to build a huge Douglas Aircraft Assembly Plant next to the depot.

Maj. Gen. Clarence L. Tinker, an Oklahoma native and part Osage Indian, lost his life while leading a group of LB-30 bombers on a mission against the Japanese in the region of Wake Island on June 7, 1942. Accordingly, Gen. H.H. "Hap" Arnold ordered the installation named Tinker Field on Oct. 14, 1942. During World War II, more than 18,000 military and civilian employees repaired and modified B-17, B-24 and B-29 bombers as well as C-47 and C-54 cargo planes. They also overhauled thousands of aircraft engines and shipped supplies around the world. Meanwhile, the Douglas Plant, employing close to 24,000 people, produced more than 5,300 C-47 Skytrain aircraft and parts to build 400 C-54 Skymaster cargo planes and 900 A-26 Invader attack bombers.

At the end of the war, the Oklahoma City Air Depot acquired the adjacent Douglas Plant complex and moved new workloads into the facilities after the War Department declared Tinker Field a permanent air base. Renamed the Oklahoma City Air Materiel Area (OCAMA) on July 2, 1946, the depot continued work on bombers, engines and aircraft parts and played an important role in supporting the Berlin Airlift. Following the creation of the Department of the Air Force in 1947, the installation officially became Tinker Air Force Base on January 13, 1948.

In the 1950s, Tinker AFB modified and repaired the B-29 Superfortress, the B-47 Stratojet, and the C-97 Stratofreighter. In 1953, OCAMA's engine line became 100-percent jet propulsion. Throughout the decade, the depot performed maintenance on such power plants as the J47, J57, and J75. In the mid-1950s, Tinker AFB assumed management responsibility for the KC-135 Stratotanker and the B-52 Stratofortress, and in 1959, completed maintenance of its first B-52 and KC-135 aircraft. With the increased importance of OCAMA in the national defense network, it soon grew and expanded its western boundary from Air Depot Boulevard to Sooner Road. The area later housed a new chapel, hospital, dormitories, enlisted and officer clubs, and modern military family housing.

In the 1960s, Tinker AFB accelerated production due to the Cuban Missile Crisis and the continued Cold War. Soon, OCAMA shifted its focus to support the Vietnam War, and Tinker AFB became an inland aerial port for Southeast Asia activities. In January 1968, Tinker AFB employment reached an all-time high of 24,778 civilians and 4,404 military members assigned to OCAMA and its associate organizations.

Tinker AFB gained new work in the 1970s as skilled employees repaired F-4 and F-105 fighter jets as well as the A-7 attack aircraft and the new TF41 engine. OCAMA became the Oklahoma City Air Logistics Center on April 1, 1974. The next year, the OC-ALC assumed management responsibility for the E-3 Sentry aircraft, and the 552nd Airborne Warning and Control Wing activated its units at Tinker AFB on July 1, 1976.

In the 1980s, the OC-ALC added management responsibilities for the B-1 Lancer and B-2 Spirit bombers and completed maintenance work on its first B-1 in 1988. More depot work on the F101, F107, F108, and F110 engines started in the mid-1980s along with management responsibilities for a host of engines. Despite

a near disastrous fire in Building 3001 in November 1984, ALC workers continued their support of warfighters throughout the world.

In 1991, Tinker AFB supported the war efforts of Operations Desert Shield and Desert Storm. A year later, the Navy's Strategic Communications Wing ONE completed its move to Tinker AFB, the first time a Navy wing had relocated to an Air Force base. The decade ended with the 1999 announcement that Tinker AFB and the OC-ALC had won the largest-ever public-private competition for an engine workload. It would be transferred from the closing ALC at Kelly AFB, Texas.

On Sept. 11, 2001, after foreign terrorists hijacked civilian airliners and crashed them into the World Trade Center in New York City, the Pentagon in Washington D.C. and a field in Pennsylvania, Tinker workers responded by providing support to U.S. troops at home and abroad in Operations ENDURING FREEDOM (starting in 2001) and IRAQI FREEDOM (starting in 2003). As in all previous wars and conflicts, the spirit of Oklahoma and America's military resolve could be vividly seen at Tinker AFB.

After the events of Sept 11th, 2001, Tinker AFB had many responsibilities and played many roles in the Global War on Terror. On 9 October 2001, the North Atlantic Treaty Organization (NATO) made history when it deployed five Airborne Warning and Control System (AWACS) aircraft to the United States. The aircraft, crews, and support personnel came from Geilenkirchen, Germany to assist the 552nd Air Control Wing (ACW) at Tinker AFB in support of Operation NOBLE EAGLE, a homeland defense operation, which continued until May of 2002.

While the 552 ACW and its NATO counter parts watched the skies, the men and women of the OC-ALC provided the aircraft, weapons, and other materiel critical to the wartime operations during Operations ENDURING FREEDOM and IRAQI FREEDOM. In the years since Sept 11, many military members from the active duty, Air Force Reserve, and Air National Guard departed from Tinker AFB to the theaters in Afghanistan and Iraq to combat our foes.

To meet the demands of the growing war effort, the Air Force authorized the activation of three new wings under the OC-ALC—the 76th Maintenance Wing, the 327th Aircraft Sustainment Wing (later inactivated June 2010), and the 448th Combat Sustainment Wing (later redesignated the 448th Supply Chain Management Wing [448 SCMW] Apr 2008)—in February 2005.

In January 2007, the OC-ALC received a mission assignment gaining new depot management responsibility for the C-32, C-37, and C-40 aircraft and the CF6-80C2-L1F engine. To more efficiently execute operations, the base capitalized on vacant close-to-base industrial space to meet mission requirements. Through a bond issue by the voters of Oklahoma County and $10M contribution by the state, the county purchased the 398-acre property and shuttered automobile assembly plant from General Motors for $54M. Through a lease agreement, Tinker used the campus moving aerospace programed depot maintenance operations into a facility with nearly 4-million square-feet of prime heavy industrial space. The Oklahoma community handed the Air Force the keys to Tinker Aerospace Complex (TAC) 9001 in October 2008. Later lauded by the Environmental Protection Agency (EPA) as one of the nation's top environmental redevelopment projects, a June 6, 2012 Brownsfield ceremony recognized the collaborative transformation of the former automobile plant to an aerospace complex with the Phoenix Award, one of the more distinguished environmental redevelopment awards in the country.

In November 2011, Headquarters Air Force Materiel Command (HQ AFMC) announced a major restructuring effort that would reduce overhead by cutting the number of centers from twelve to five. For Tinker AFB, the five center construct meant the establishment of a new organization on base, the Air Force Sustainment Center (AFSC). On July 10, 2012, the AFSC was activated at Tinker

AFB as the center in charge of the three air logistic complexes and three airbases (Hill AFB, Robins AFB and Tinker AFB) and the two supply chain wings (448 Supply Chain Management Wing at Tinker AFB (TAFB) and 635th Supply Chain Operations Wings at Scott AFB, Illinois). With the establishment of AFSC came new management responsibilities and tools to effectively and efficiently command the large organization.

In 2015, Tinker Air Force Base officials announced the acquisition of 156 acres of land on the southwest side of the base to stand up a depot maintenance facility for the Air Force's next-generation aerial refueling aircraft, the KC-46A Pegasus. The land purchase was made possible through a joint effort of the U.S. Air Force ($8 million), the City of Oklahoma City ($23.5 million) and Oklahoma County ($12.5 million). The land was formerly owned by the Burlington Northern Santa Fe Railway Co., where it operated a rail yard that primarily served the former General Motors manufacturing facility. Current facility requirements for the KC-46A depot maintenance operations include approximately 840,000 square feet of facilities to include 14 aircraft bays, a 10-meter engine test cell (to be located on the TAC 9001 facility), a kitting facility, a software integration lab, warehouse space, support facilities such as central chiller plant and fire pump house, taxiways, aircraft parking positions, an engine run up ramp (to be located on the TAC grounds), and approximately 1,250 personal vehicle parking spots.

2.1.3 Military Missions

Today, Tinker's vital Air Force mission continues to be dedicated to providing worldwide technical logistics support to Air Force aerospace weapon systems, equipment, and commodity items, and encompasses a myriad of responsibilities. OC-ALC has the unique mission of managing and repairing the engines that power cruise missiles and a variety of Air Force and Navy aircraft. The center also accomplishes aircraft modifications and repairs, maintains, and overhauls bombers, refuelers, and reconnaissance aircraft including the B-1B, B-2, B-52, E-3, and the C/KC-135 series aircraft. It performs depot level maintenance (i.e., high level overhaul maintenance such as engine removal and rebuild, painting, etc. as opposed to routine maintenance) on more than 120 aircraft annually. It also organizes, directs, and controls total life-cycle management of over 1100 aircraft. The center also manages the SRAM, SRAM II, ACLM, and GLCM missile systems, as well as the Air Force's Harpoon missile. The ALC annually overhauls and maintains more than 3,000 major jet engine modules from 11 major commands as well as the Army, Navy, and numerous foreign countries. In addition to aircraft/missile maintenance, overhaul, and repair, Tinker AFB provides deployable communications, computer systems, navigational aids, and air traffic control services worldwide for Air Force, Department of Defense, and other U.S. commitments.

Listing of Tenants and NR Responsibility	
Tenant Organization	**NR Responsibility**
List tenant organizations	*Identify which host/tenant organization is responsible for managing tenant's impact to/by natural resources (i.e., Unit Environmental Coordinators, UECs)*
552nd Air Control Wing	Shannon Reimers-Wavada
507th Air Refueling Wing	Kayla Cuffie
513th Air Control Group	Lt Col Brian Hard
U.S. Navy's Strategic Communications Wing One	Curtis Murtchinson
38th Cyberspace Engineering Installation Group	Thanh Alcorn
Defense Megacenter Oklahoma City (DLA)	Ryan Henry

Grounds Maintenance Contractor (Trace)	Patricia Troxell
Force Support Squadron	Dale Rogers/Marvin Broughton
CE Operations (Alutiiq)	Noland Voss/Michael Heustis
AAFES	Raymond Becker
72 LRS	Joshua Morris/Guy Wilson/Ralph Farley
Motorpool	Randall Hixson
76 AMXG	Chris Ray/Marty Allen
76 PMXG	Michael McGill/Rachel McArthur
76 CMXG	Brandi Dittrich/Tommy Fagan
76 SWEG	Torrie Wale/Michael Kessler
76 MXSG	Torrie Wale/Michael Kessler
76 MXSG/MXDEU	Christopher Ray
72 MDSS	Kelly Guest
72 SFS	Travis Morris/Shawn McClelland
72 ABW/SC	Jake Langham/Mark Holder
72 ABW/CEF	Robin Lewallen/Nathan Schooling
72 ABW/CEIEC	Kyle Barton/Mary Downs

2.1.4 Surrounding Communities

Midwest City: Starting in 1941, Midwest City was developed simultaneously with the rise of Tinker AFB. According to the 2010 US Census, the current population is 54,371, with little growth in the last ten years. It is the eighth largest city in the state and is a part of the Oklahoma City metropolitan area. The community covers about 25 square miles on the north side of Tinker AFB. The racial makeup of the city is 64.6% white, 21.9% African American, 5.6% Hispanic/Latino, 3.7% Native American, 1.7% Asian, 0.1% Pacific Islander, and 6.5% from mixed races. The medium income for a household in the city was $42,117. Most of Midwest City is suburban, being slightly more rural in the eastern half of the city.

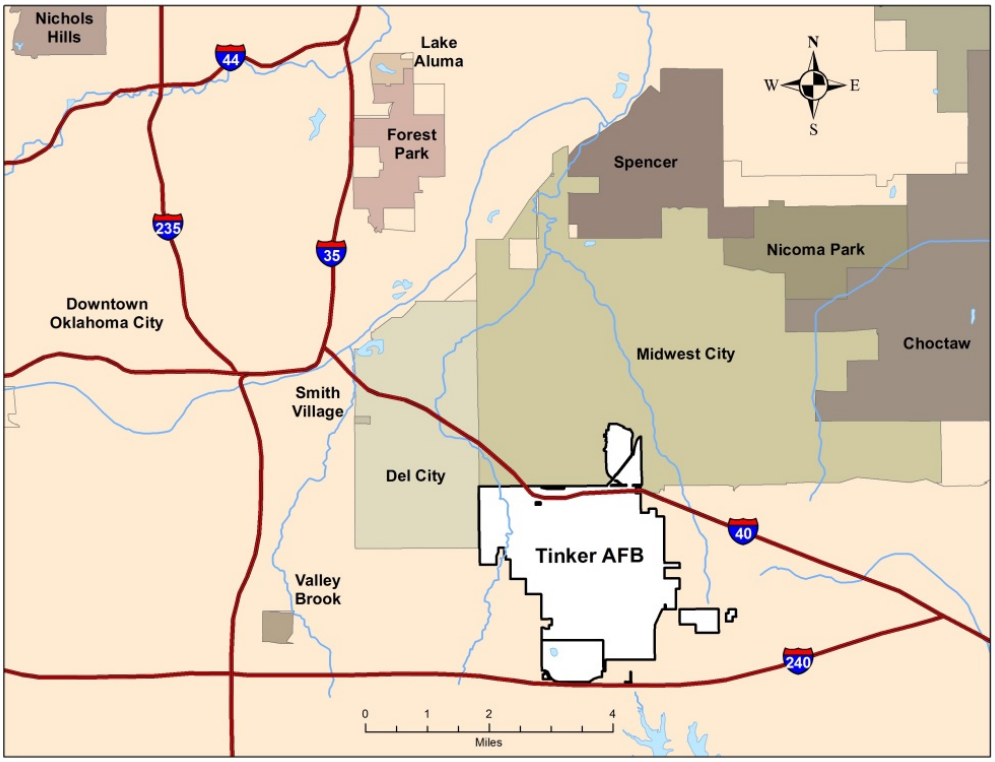
Del City: Bordering most of Tinker AFB's western boundary is Del City which covers 7.5 square miles. It is a part of the Oklahoma City metropolitan area. The current population is about 21,000, which is down by 3.6% since 2000 and down by 25.2% from its peak population of 28,523 in 1980. The racial composition is 66.4% white, 17.7% African American, 7.2% Hispanic/Latino, 4.3% Native American, 1.6% Asian, 0.2% Pacific Islander, and 7.6% of mixed race. The medium household income was $40,240. Del City is a mostly suburban community.

Oklahoma City: Tinker AFB is bordered on the southwest, south and east sides by portions of Oklahoma City, the largest city in the state with a population of 579,999. It is the 31st largest city in the United States and is the 8th largest city in the nation by land area at 606 square miles. From 2000 to 2010, the population increased by 14.6%. The racial composition is 62.7% white, 15.1% African American, 17.2% Hispanic/Latino, 3.5% Native American, 4.0% Asian, 0.1% Pacific Islander, and 7.2% of mixed race. The median household income is $43,798. Agriculture, oil, natural gas, petroleum products, and related industries are the largest sector of the regional economy.

Due to its relatively undeveloped state, the adjacent Oklahoma City land area has the greatest potential to positively or negatively impact Tinker AFB. For planning purposes, the Oklahoma City Planning Department has divided the city into six sectors. The portion of Oklahoma City that adjoins Tinker AFB is the Southeast Sector. It is considered one of the city's areas of highest suburban growth and acreage development. Although Oklahoma City as a whole is comprised of urban, suburban, and rural community

areas, the Southeast Sector is predominantly suburban and rural. The western one-third of the sector is suburban and the eastern two-thirds is mostly rural, including fairly large areas of undeveloped land.

Within the Southeast Sector Plan, land immediately east of Tinker has been designated as industrial for future Tinker AFB expansion. There are limited areas within the Southeast Sector near Tinker that could support new commercial, industrial, and higher density residential development. Land south of Tinker is being managed as a drinking water supply watershed and reservoir.



Tinker AFB Location (Surrounding Communities)

2.1.5 Local and Regional Natural Areas

Land south of Tinker—Lake Stanley Draper and adjoining West Elm Creek Reservoir preserve—has been designated as an Environmental Conservation Area. It is located about one mile from Tinker AFB and totals over 10,000 acres.

Lake Stanley Draper is 2,900 acres with a 34 mile shoreline and is located one mile south of the installation's primary runway. It serves as a water supply and recreation reservoir. Recreational activities include angling, camping, picnicking, jet-skiing, sailing, and boating. A multiuse recreational trail—Tinker-Draper Trail—loops around the lake and connects to Tinker's perimeter. Preliminary plans call for the Tinker-Draper Trail to extend from the North Canadian River at the Interstate 40/Interstate 35 junction and extend to the southeast through Del City to the north side of Lake Stanley Draper.

The West Elm Creek Reservoir preserve is comprised of land on the west side of Lake Stanley Draper and is set aside for potential use as a water supply reservoir in the future. If West Elm Creek Reservoir were built, it would be an encroachment issue for the base flying mission since the reservoir would be one mile

south-southeast of the end of the base's main runway and would be certain to increase large resident and migratory water bird activity.

Approximately one-half of the Environmental Conservation Area falls within the Central Oklahoma/Texas Plains ecoregion (upland and bottomland forest with scattered prairies), and the other half in the Central Great Plains ecoregion (prairie uplands with woodlands along streams). Most of Tinker AFB is in the latter ecoregion with some fringe areas in the former. In recent years, one endangered species has been identified near Lake Stanley Draper in the Central Oklahoma/Texas Plains ecoregion habitat type. This species has not been identified during surveys on Tinker AFB.

There are no federal wildlife refuges, state wildlife management areas, or other nature parks/greenways within five miles of Tinker AFB.

2.2 Physical Environment

2.2.1 Climate

TAFB's climate is officially classified by the United States Department of Agriculture (USDA) as warm subhumid with pronounced day-to-day changes and gradual seasonal changes, although the changes of seasonal weather conditions are very dramatic. Summer temperatures above 90 degrees Fahrenheit (F) are not uncommon, occurring on the average 71 days during the year. The maximum-recorded temperature is 109 degrees (F). Temperatures in the winter on the average are not frigid, but when combined with gusty winds can yield wind-chill temperatures in the below 0 degrees (F) range. The lowest recorded temperature at Tinker is –7 degrees (F). Temperatures below 30 degrees (F) occur on the average 86 days of each year. Temperatures in the spring and fall are generally mild with warm days and cool nights. The average amount of measurable precipitation per year is 33.3 inches which is almost entirely offset by evapotranspiration (see Tab 8). The average number of days per year with measurable precipitation is 75. Of the 75, an average of 47 are thunderstorms and 6 are snowfall. Winds on the average are from 12-14 mph (highest recorded – 87 mph) and predominant direction is from the south-southeast.

The following statistical summary has been compiled from weather observations taken at TAFB from January of 1943 through March of 1984 for averages, and January 1943 through June of 1990 for extremes (Source: Detachment 1, 17th Weather Squadron, Tinker Air Force Base, Oklahoma).

MONTH	MAX. TEMP. (F)	AVERAGE HIGH TEMP. (F)	AVERAGE LOW TEMP. (F)	MIN. TEMP. (F)	AVERAGE PRECIPIT-ATION (INCHES)	AVERAGE HUMIDITY (PRESENT)
JANUARY	80	46	27	-7	1.3	60
FEBRUARY	85	52	32	-1	1.3	62
MARCH	91	60	39	-1	2.3	59
APRIL	98	71	51	25	3.1	61
MAY	104	78	59	35	6.1	68
JUNE	106	87	68	51	4.1	67
JULY	109	92	72	53	3.3	60
AUGUST	107	92	71	56	2.3	61
SEPTEMBER	107	84	64	37	3.3	62
OCTOBER	98	74	53	26	2.9	58
NOVEMBER	84	60	40	11	1.9	62
DECEMBER	85	50	31	0	1.4	59

General descriptions of seasonal weather conditions are:

Spring (March-April-May-June): Spring yields the type of weather that Oklahoma is perhaps best known for; thunderstorms, sometimes severe, with locally heavy rainfall, gusty winds, hail, frequent lightning, and possibly tornadoes. Though severe thunderstorms can and have occurred during every month of the year, they are most frequent during the spring. Consequently, spring is the wettest season in Oklahoma receiving about 36% of the average annual precipitation.
Summer (June-July-August-September): Summer is best characterized as hot and humid. Temperatures above 100 degrees (F) in July and August are not uncommon. About 29% of the average annual precipitation occurs during the summer.

Fall (September-October-November-December): Fall is commonly known for warm days and cool nights. The average first frost at TAFB occurs in early November around the 7th. On the average, about 21% of Oklahoma's annual precipitation occurs in the fall. The spring, summer, and fall collectively constitute an average growing season of approximately 224 days.

Winter (December-January-February-March): The winter season is not only Oklahoma's coldest season but is also the driest. Roughly 14% of Oklahoma's average annual precipitation occurs during the winter. The average annual latest frost in Oklahoma occurs on about the 28th of March.

Climate projections for Tinker Air Force Base (See table, "Summary Climate Data") suggest minimum and maximum temperatures will increase over time under two emission scenarios – a moderate carbon emission scenario (Representative Concentration Pathway [RCP] 4.5) and a high emission scenario (RCP 8.5). The potential impact of these two climate change scenarios on the site's natural resources was analyzed using extracted climate data from 2026 to 2035 to represent the decadal average for 2030, and extracted data from 2046 to 2055 for the decadal average for 2050.

For the decade centered around 2030, both of the scenarios project a similar degree of increase in average annual temperature (TAVE) of between 2.6 °F (1.4 °C) and 3.9 °F (2.2° C) over historic average. The two emission scenario projections show higher warming by 2050, with RCP 4.5 expressing a warming of 3.6 °F (2.0 °C). RCP 8.5 expresses a slightly greater warming of 5.1°F (2.8 °C) for this period.

Average annual precipitation (PRECIP) varies between emission scenarios and over time due to larger interconnected ocean-atmosphere dynamics associated with the NCAR CCSM model. For 2030, RCP 4.5 scenario projects an increase in PRECIP of 11% while RCP 8.5 shows a more modest increase of 1%. For 2050 RCP 4.5 projects an increase in PRECIP of 14% while RCP 8.5 shows a smaller increase of 5%.

Summary Climate Data

Variable	Historical	RCP 4.5		RCP 8.5	
		2030	2050	2030	2050
PRECIP (inches)	39.4	43.6	44.9	39.9	41.5
TMIN (°F)	49.2	51.6	52.5	53.1	53.9
TMAX (°F)	72.0	74.7	76.0	75.9	77.5
TAVE (°F)	60.4	63.1	64.2	64.4	65.7
GDD (°F)	5367	5973	6148	6214	6490
HOTDAYS	64.1	91.0	102.0	100.7	113.4
WETDAYS	1.3	0.4	1.2	0.1	0.4

Notes: TAVE ºF = annual average temperature; TMAX ºF = annual average maximum temperature; TMIN ºF = annual average minimum temperatures; PRECIP (inches) = average annual precipitation; GDD ºF = Average annual accumulated growing degree days with a base temperature of 50 ºF; HOTDAYS (average # of days per year) = average number of hot days exceeding 90 ºF; WETDAYS (average # of days per year) = annual number of days with precipitation exceeding 2 inches in a day.

Understanding changes in daily intensity and total precipitation for multi-day precipitation events is helpful to evaluate precipitation patterns in addition to assessment of annual averages. Three-day storm events were generated from projected precipitation data based on RCP 4.5 and 8.5 emission scenarios for the 2030 and 2050 timeframes (see table, "Design Storm Precipitation"). Historical precipitation data were used to calculate a baseline storm event for the year 2000 for comparison. Estimated storms were used as design storm to model stream channel overflow in the hydrology assessment.

Design Storm Precipitation

Design Storm		Baseline	RCP 4.5		RCP 8.5	
		2000	2030	2050	2030	2050
Precipitation (inches)	Day 1	1.5	1.3	2.8	1.1	1.5
	Day 2	2.4	1.7	3.5	2.0	1.7
	Day 3	1.6	2.1	1.9	1.2	1.9
	Total	5.5	5.1	8.2	4.3	5.1
Percent change from baseline			-7%	49%	-22%	-7%

For more information on climate change impacts to Tinker Air Force Base, refer to Sections 2.2.4, 2.3.1, 2.3.2, 2.3.3, 2.3.5, 2.4.1, 7.1, 7.2, 7.7, 7.9, and Tab 8.

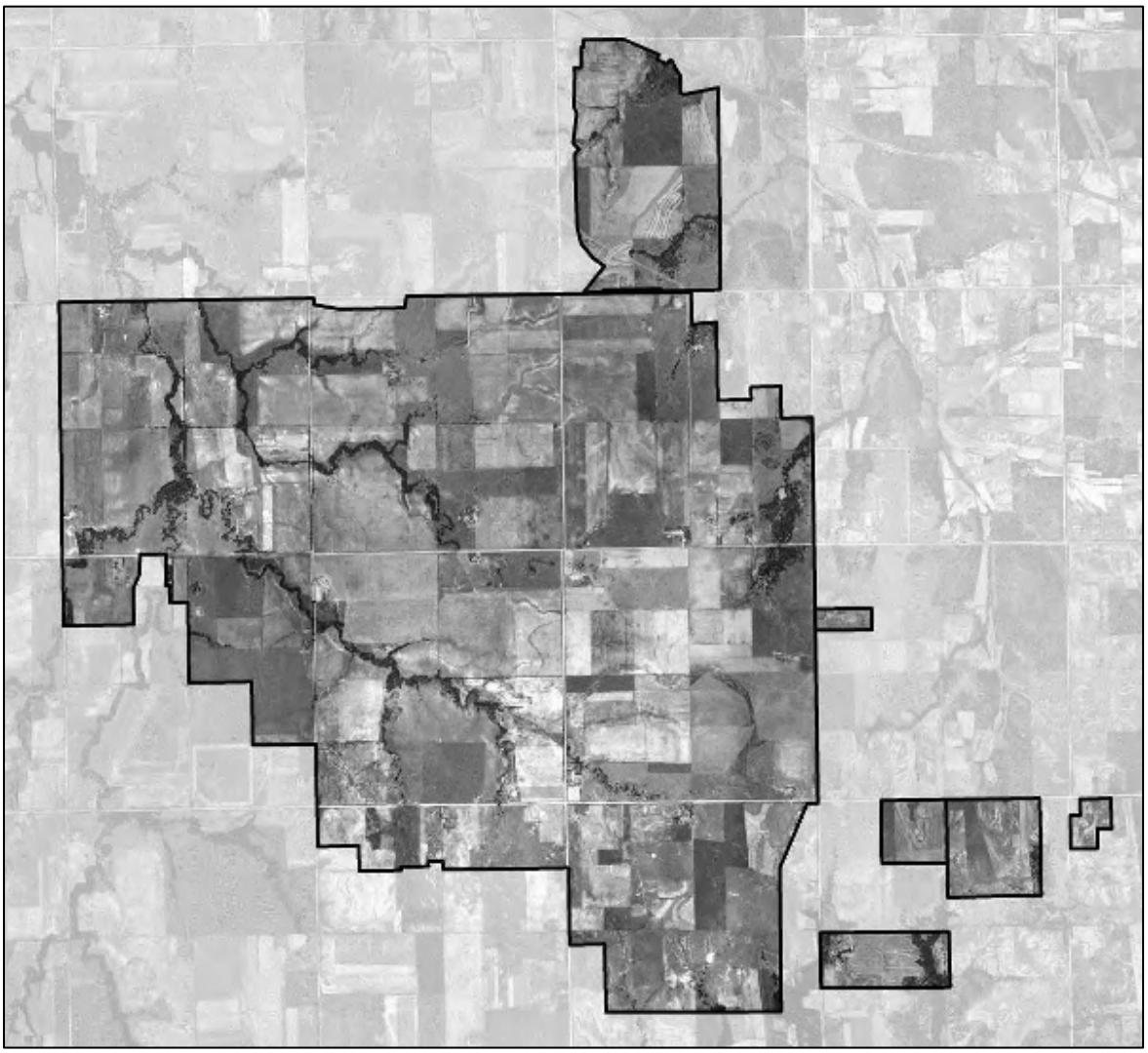
2.2.2 Landforms/Physiography

Tinker AFB is located in the Central Redbed Plains section of the Central Lowland Physiographic Province which is characterized by level to gently rolling hills, broad flat plains, and bottomlands bisected

by small- to medium-sized water courses. Oklahoma County elevations range from about 850 feet above mean sea level (MSL) in the southeastern part to 1300 feet MSL in the northwestern part. Tinker AFB elevations range from approximately 1200 feet MSL (Crutcho Creek - northwestern portion of Tinker AFB) to 1310 feet MSL (southeast portion of Tinker AFB). Airfield elevation is approximately 1291 feet MSL.

2.2.3 Geology and Soils

Early aerial photographs indicate the majority of land currently occupied by Tinker AFB was used for agricultural purposes (see figure, "Tinker AFB Agriculture"). Soil tillage and terracing are evident on historic aerial photographs, indicating much land was farmed before Tinker AFB was established.



Tinker AFB Agriculture: Historic aerial photograph of land now occupied by Tinker AFB illustrates substantial agricultural activity across the landscape.

Borrowing soil from various on-base locations to build up facility foundations and level the airfield was the primary soil impact during initial urbanization and industrialization of Tinker AFB. Later, soil was borrowed from select Tinker AFB locations and utilized for capping landfills. Some of these borrow sites,

up to 10 acres in size, had both the topsoil and subsoil permanently removed. No topsoil was replaced at these locations; consequently, revegetation was slow and led to further soil loss by erosion.

Physical properties of soils have been altered by military construction and activities. For example, vehicular traffic around construction sites and parking aircraft on grassed areas have compacted soils. However, placement of metal runway matting to facilitate aircraft movement on wet soils would have lessened the compaction (see figures, “Tinker Airfield”). Much soil was excavated and redistributed/compacted for projects such as large storm drainage systems across Tinker AFB.

Tinker Airfield: Hundreds of aircraft parked on grassed areas of Tinker's Airfield in the 1940’s.

Tinker Airfield: Metal runway matting placed on vegetated areas of the airfield in 1944.

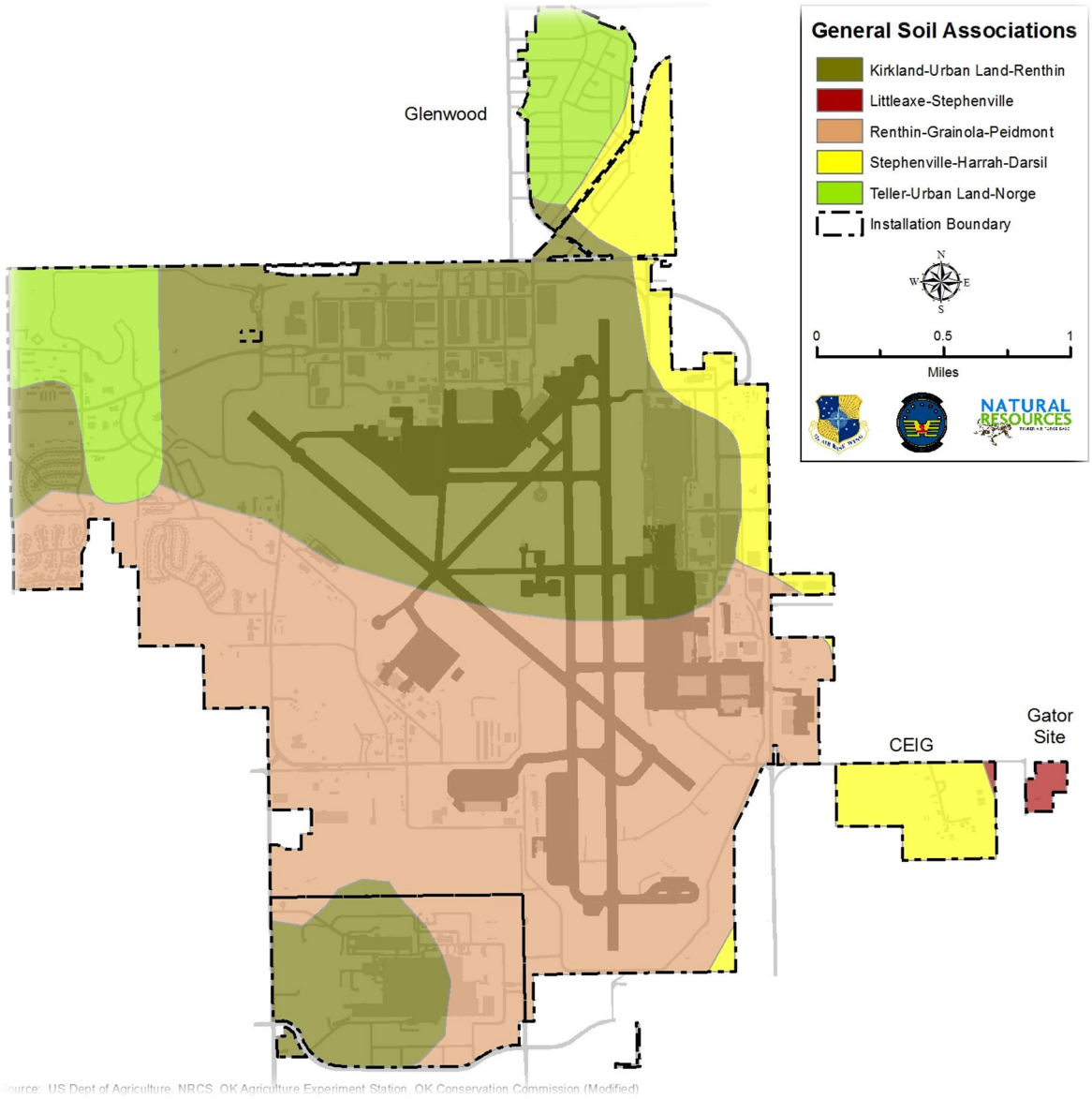
Accelerated soil loss has occurred because of unnatural creek bed erosion. Creek channelization and intensified runoff from developed areas has resulted in bed scour and deeply incised channels. Displaced soil is transported downstream and typically not replaced by aggradation because of the creek system's current morphology.

Highly fertile soils have been lost to other land uses and development. Many areas classified as prime farmland have been converted to other uses such as recreational land use (e.g., golf course).

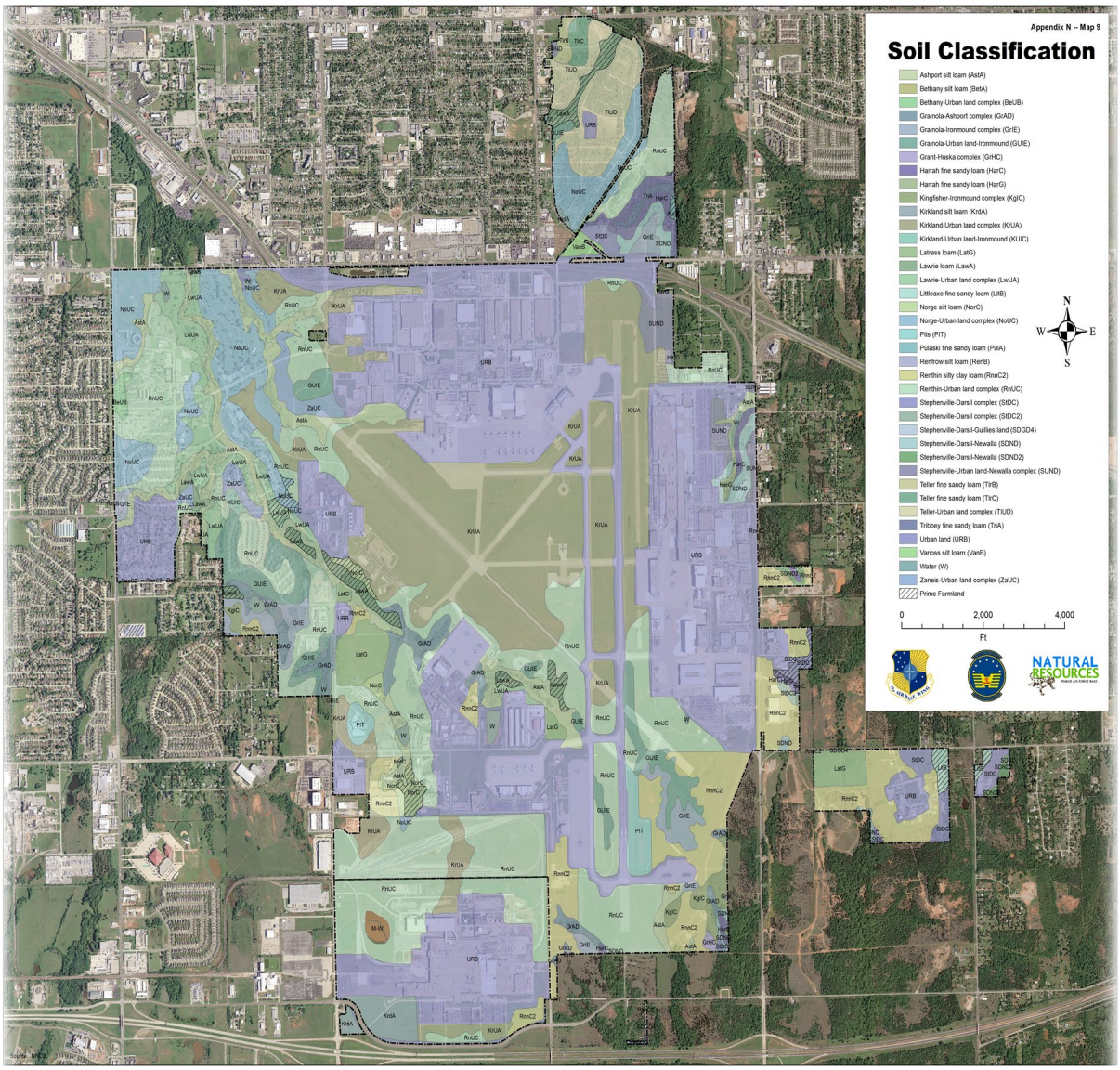
Geology (Surficial Soils)

Soil Associations: According to the United States Department of Agriculture Natural Resources Conservation Service (USDA NRCS, 1996), Tinker's soil is comprised of five major associations (see figure, "Soil Associations"):

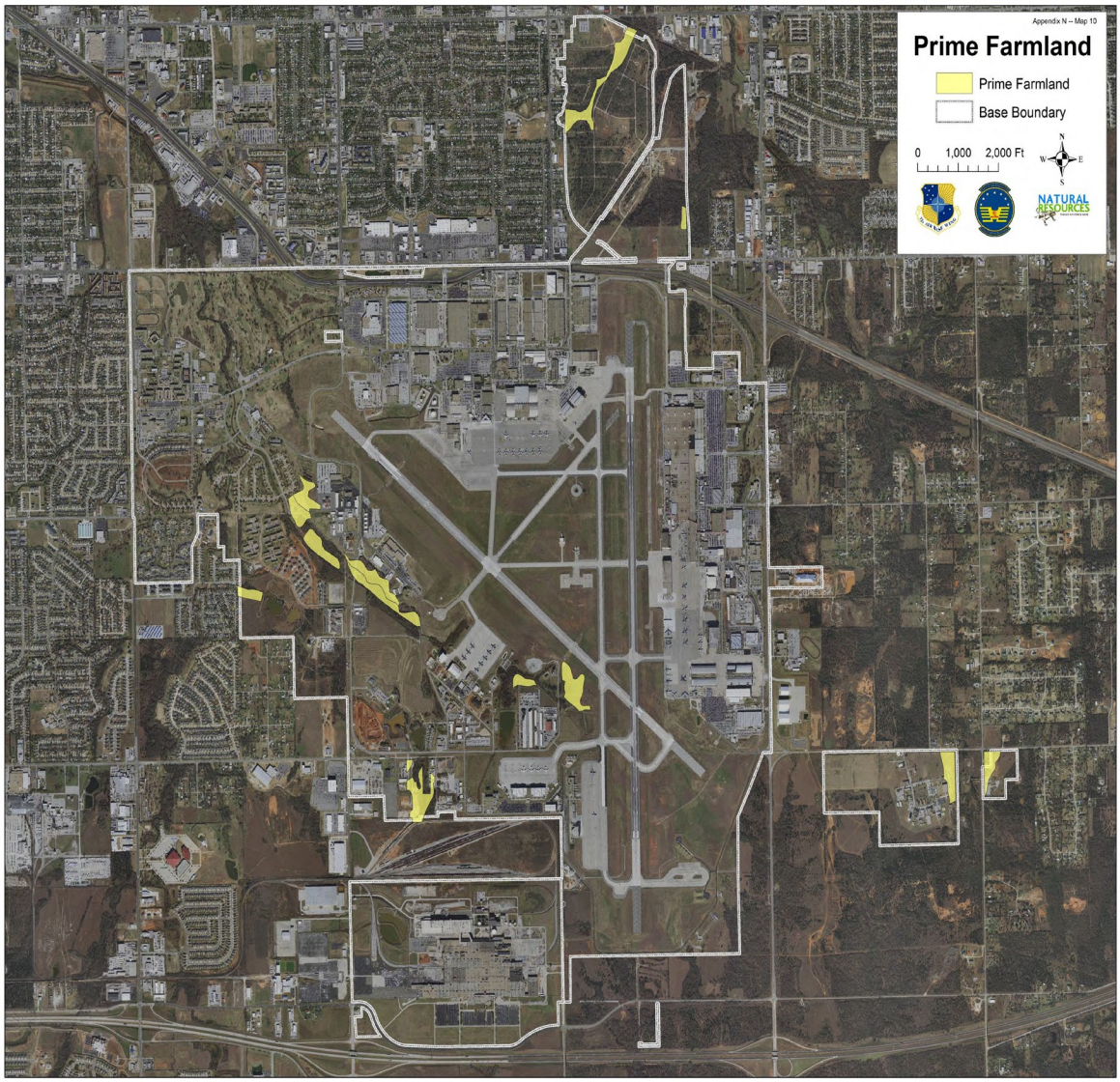
1. *Kirkland-Urban Land-Renthin*: Areas of very deep and deep well-drained, clayey soils in areas of Urban land; on prairie uplands;
2. *Littleaxe-Stephenville*: Deep and moderately deep, well-drained, loamy soils on forested uplands;
3. *Renthin-Grainola-Peidmont*: Deep and moderately deep, well-drained, clayey soils on prairie uplands;
4. *Stephenville-Harrah-Darsil*: Very deep, moderately deep, and shallow, well-drained and excessively drained, loamy and sandy soils on forested uplands;
5. *Teller-Urban Land-Norge*: Areas of very deep, well-drained, loamy soils and areas of urban land; on terraces.



Tinker AFB Soil Associations



Tinker AFB Soil Types



Undeveloped Tinker AFB Prime Farmland

Soil Types: Tinker's soil survey was initially completed by the United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) in 1983 and updated in 1996. Thirty-four soil types have been identified within Tinker AFB boundaries (Figure Tinker AFB Soil Types). Prior to development, approximately 300 acres of land currently occupied by Tinker AFB would have been classified as prime farmland. In 1983 and 1996, eighty-nine and seventy-eight acres, respectively, were classified as prime farmland on Tinker AFB. Further in-house refinement (i.e., accounting for roads, parking lots, playgrounds, etc.) brought the seventy- eight acres down to the present day sixty-three acres of undeveloped prime farmland on Tinker AFB (see figure, "Undeveloped Tinker AFB Prime Farmland").

Prime farmland is defined as land that has the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops, and is currently available for these uses (i.e., the present land use could be cropland, pasture land, rangeland, forest land, or other land, but not urban built-up land or water). Prime farmland has soil quality, growing season, and moisture supply needed to economically produce sustained high yields of crops when treated and managed, according to acceptable farming methods. In general, prime farmland has adequate and dependable moisture supply from precipitation or irrigation, favorable temperature and growing season, acceptable acidity or alkalinity, acceptable salt and sodium content, few or no rocks, and is permeable to water and air. Furthermore, prime farmland is not excessively erodible or saturated with water for long periods of time, and either does not flood frequently or is protected from flooding.

Soil on Tinker AFB has been very suitable for construction purposes. In the mid-1980s and 1990s, Landfills 1, 3, and 6 were capped using clay excavated from the present day Redbud, Primrose/Wood Duck, and Prairie Ponds, respectively.

Geology (Lithology)

According to Bingham and Moore (1975), surficial geology was dominated by the Garber Sandstone stratum with relatively smaller stratigraphic units of the Hennessey Group, Terrace Deposits, and Alluvium. Wood and Burton (1968) reported Tinker AFB was almost exclusively underlain with the Hennessey Group (Kingman Siltstone and Fairmont Shale) with one small area underlain with Garber Sandstone/Wellington Formation, and one area with Alluvium stratigraphic unit. A 1988 U.S. Army Corps of Engineers report stated the Garber-Wellington Formation underlies the entire Tinker AFB with the Hennessey group overlapping the southern half of Tinker AFB.

Recent drilling and construction of cross-sections confirm the erosional edge of the Hennessey Group extends from the northwest corner of Tinker AFB southeastward to the Engineering Installation Group (EIG) area. Over ¾ of Tinker AFB surface geology is Hennessey. Most of the remaining surface geology is Garber Sandstone with some alluvium along streams.

Furthermore, recent work shows surface Hennessey is underlain by Garber Sandstone, which in- turn is underlain by Wellington Formation. Sandstone and mudstone comprise the majority of Tinker's surficial geology (Bingham and Moore, 1975; Wood and Burton, 1968). Sandstone is orange-red to reddish-brown, fine-grained, and poorly cemented with subangular to sub-rounded grains composed of quartz. Shale is reddish-brown and silty.

2.2.4 Hydrology

Based on topography and historical aerial photos, it appears that pre-settlement surface waters on land currently occupied by Tinker AFB consisted only of lotic waters (i.e., streams). There is no known evidence of the presence of lentic waters (e.g., ponds, lakes, wetlands) for that time period, although small beaver-created ponds and wetlands may have occurred along stream systems much as they do today. Streams

consisted of intermittent, ephemeral, and possibly perennial flows in wooded or non-wooded stream systems which bisected gently rolling hills of tall/mixed-grass prairie. These systems were typically shallow with broad, relatively flat floodplains (see figure, "Pre-settlement Stream Morphology"). Floodplain areas closest to the streams may have been heavily vegetated with riparian trees and shrubs; however, it is likely natural fire events would have kept most, if not all, woody vegetation suppressed such that land currently occupied by Tinker AFB was treeless (except for the upland eastern extremity of the base). Alternatively, it may have been just the more outlying floodplain fringes and the upper reaches of the first order stream segments that remained free of woody riparian vegetation.

Surface waters occurred in three main stream systems, one which drained to the north (current Crutcho Creek with Kuhlman and Soldier Creek tributaries) and two to the south (current East Elm Creek and West Hog Creek). The north-flowing stream system originated approximately two miles south of Tinker's current southern boundary with on-base portions of the system composed of twelve first order segments, two second order segments, and one third order segment. The south-flowing systems consisted of only first and second order tributaries with higher order tributaries located off-base. Stream flows were generated primarily by precipitation runoff and were probably relatively sluggish. Groundwater seepage and springs may have caused perennial flows in some of the higher order stream segments, particularly in tributaries on the eastern side of Tinker AFB.

Pre-settlement Stream Morphology: This stream in northwest Oklahoma has typical stream morphology and characteristics which would have been associated with Tinker AFB streams during pre-settlement times.

Flooding, which would have occurred naturally during pre-settlement times, likely would have been prevalent in second and higher order streams. However, the large expanses of densely vegetated native prairie would have slowed runoff and fostered greater water infiltration into the soil which would have lessened the degree of flooding. This would have in-turn increased groundwater recharge in subsurface aquifers. Pre-settlement groundwater was expansive and probably consisted of ephemeral and perennial aquifers which were under water table or confined conditions.

As would be expected in a highly urbanized setting, hydrological processes (e.g., water infiltration, runoff) on and around Tinker AFB have changed dramatically since pre-settlement times. Current processes are in a state of disequilibrium. Some of the more prominent reasons for this include past activities such as stream bed channelization, woody riparian vegetation removal, spill gate structure

installation, and stream system maintenance activities such as mowing, bank re-sloping, and rip-rap placement for erosion control. Additional negative influences include subsurface drainage network installation such as storm sewers; base-wide soil compaction; impermeable surface increase such as roads, runways, and buildings; construction of numerous retention and detention ponds; groundwater extraction for various uses/remediation activities; past water inputs from urban and industrial operation effluents; suppression of natural ecological processes such as fire and flooding; and alteration of dense, native, upland prairie groundcover.

The majority of on-base portions of watersheds have been developed into residential/industrial areas, airfield, and golf course with only some small areas remaining undeveloped. This, in combination with subsurface storm sewer systems and channelization, has resulted in very flashy, flood-prone stream systems during storm events. Tremendous volumes of water and sediment are transported within the systems in a very short time. This has significantly altered creek bed morphology, with most riparian areas having no resemblance to pre-settlement systems. Degradation is occurring in most Tinker AFB stream channels (i.e., eroding and incising with little sediment deposition). Aggradation, which normally occurs at spill gate dams and at major confluences, requires periodic removal. Much of the natural floodplain functions and values on Tinker AFB, such as floodwater storage, filtering, groundwater recharge, fish and wildlife habitat, and others, have been lost or greatly diminished.

Effects of Climate Change on Hydrology

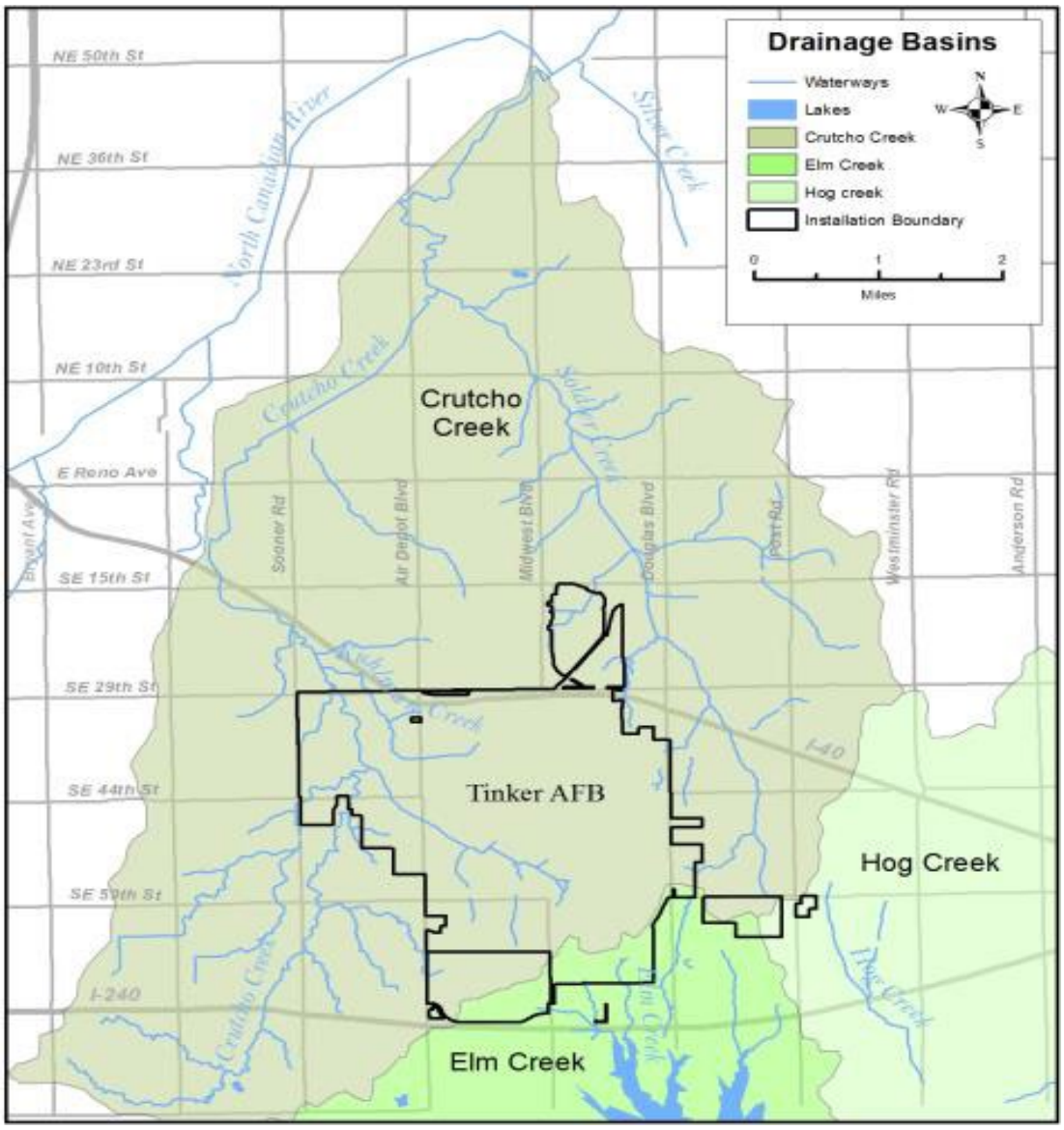
For information on projected climate change impacts on hydrology, refer to Section 2.3.5.

Surface Water (Streams and Ponds)

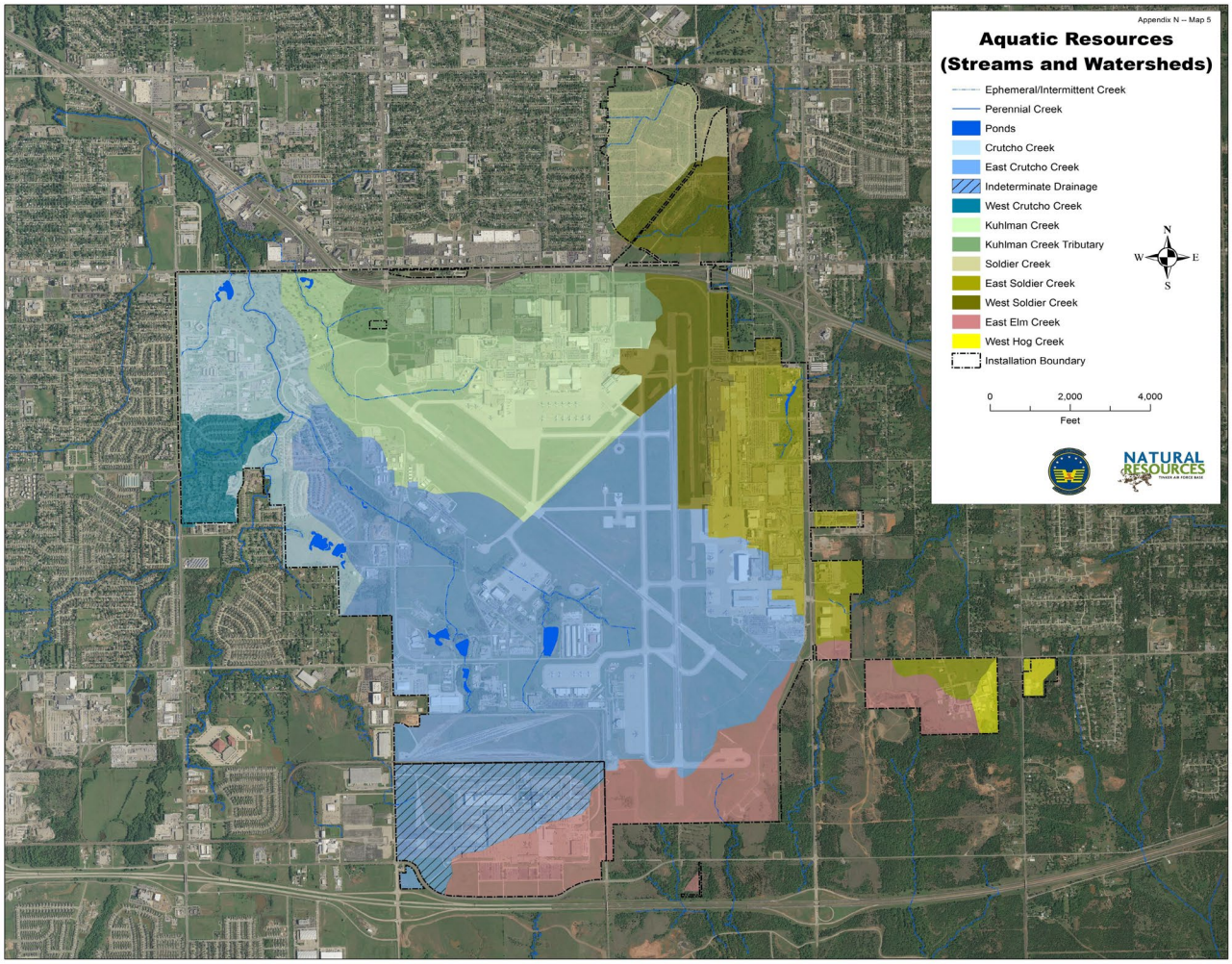
Today, Tinker's surface drainage occurs in three primary drainage basins: 1) Crutcho Creek Drainage Basin, 2) Elm Creek Drainage Basin, and 3) Hog Creek Drainage Basin (see figure, "Creeks and Drainage Basins [Local Area]"). The majority of Tinker's land is drained by Crutcho Creek Drainage Basin which flows north into the North Canadian River. Eventually the North Canadian River combines with the Arkansas River, Mississippi River, and finally discharges into the Gulf of Mexico. Elm Creek and Hog Creek Drainage Basins flow south of Tinker AFB into the Little River which forms confluences with the South Canadian River, Arkansas River, Mississippi River, and discharges into the Gulf of Mexico. The Elm Creek Drainage Basin is a sensitive watershed as it supplies Lake Stanley Draper, a drinking water supply reservoir for several local communities. The reservoir is located approximately ½ mile south of Tinker's southeast boundary.

Tinker AFB, lotic (i.e., flowing) waters (see figure, "Creeks and Watersheds [Tinker AFB]") comprise a total of about eight linear miles. The first and second order stream segments are typically ephemeral or intermittent while the third order segment is perennial. All Tinker AFB creek flows are the result of storm water runoff and groundwater seepage (i.e., groundwater enters the stream over a longer segment of the stream than a point source), with the exception of Soldier Creek which may be spring-fed (i.e., groundwater enters the stream at a point source) where the creek starts on the north side of the Cyber Engineering Installation Group at SE 59th Street. This spring-fed stream becomes a losing stream—feeding the groundwater—a short distance downstream).

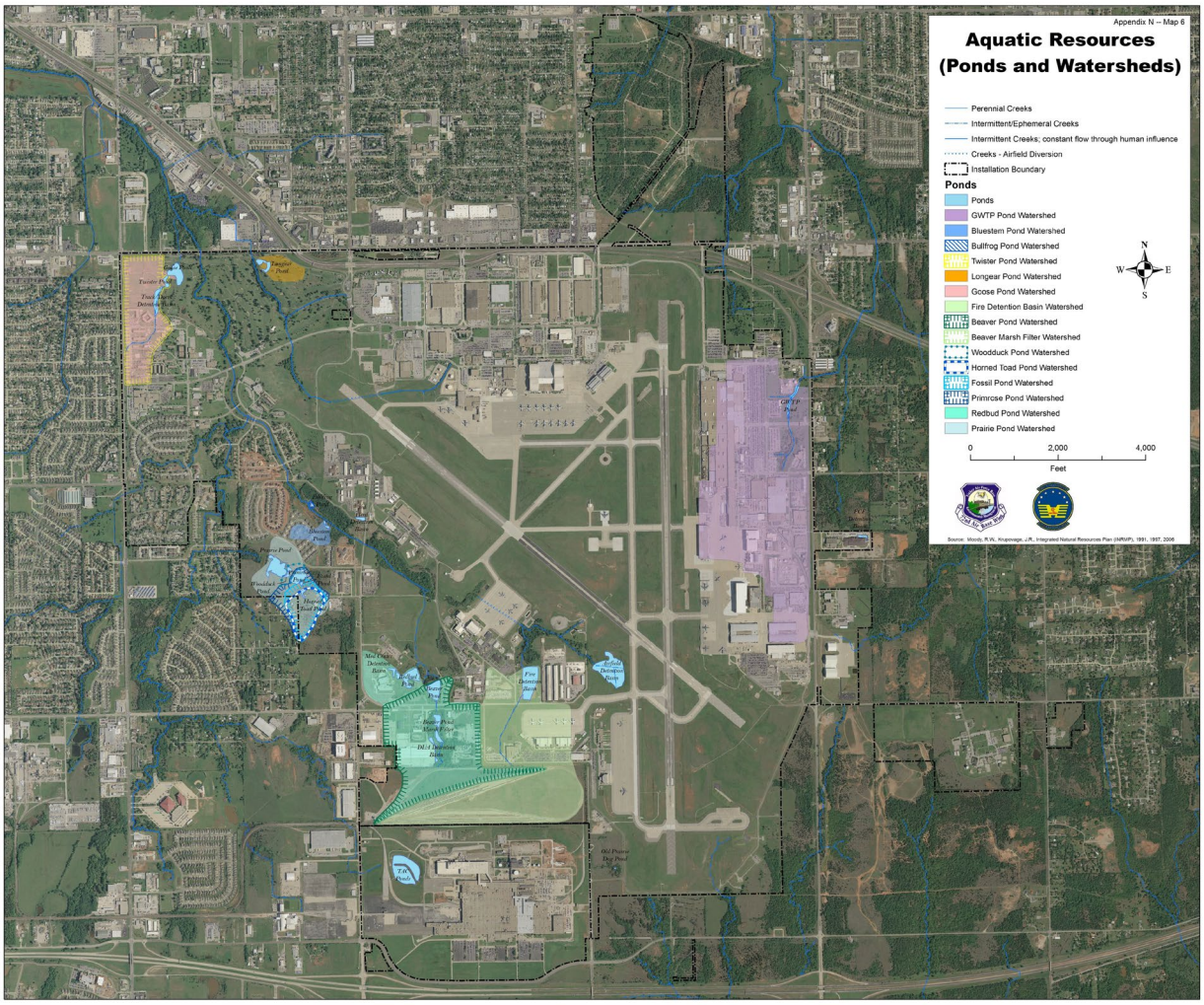
There are 15 small man-made retention ponds and seven detention basins located on Tinker AFB (see figure, "Tinker AFB Ponds and Associated Watersheds").



Creeks and Drainage Basins (Local Area): Tinker AFB and surrounding communities' creeks and associated drainage basins.



Creeks and Watersheds (Tinker AFB): There are ten sub-watersheds for creeks on Tinker AFB.



Tinker AFB Ponds and Associated Watersheds

Ground Water

Groundwater at Tinker AFB is found under either water table or confined conditions. The depth to groundwater varies from a few feet below ground surface to about 70 feet below ground surface depending on the local topography. Across Tinker AFB, water can sometimes be found in shallow, thin, discontinuous perched zones located above the aquifer.

Primary subsurface water zones identified at Tinker AFB include the Hennessey Water Bearing Zone, the Upper Saturated Zone (formerly the "Perched" Zone), the Lower Saturated Zone (formerly the "Top of Regional" and "Regional" aquifers), and the Producing Zone. Tinker AFB is located in a recharge area for these water-bearing zones; groundwater is derived primarily from precipitation and from infiltration of surface streams.

The Upper Saturated Zone, the Lower Saturated Zone, and the Producing Zone are colloquial terms to TAFB and are used to designate three identifiable saturated zones that comprise the upper portions of the

Central Oklahoma Aquifer under the base. The Central Oklahoma Aquifer underlies about 3,000 square miles of central Oklahoma. The shallowest two saturated zones occur in the Garber Sandstone whereas the Producing Zone spans the lower part of the Garber and extends into the Wellington Formation. The Producing Zone provides potable water and water for industrial use to the main portion of the base as well as two satellite areas to the east. Because of the increased yield from the Garber Sandstone and the Wellington Formation, this portion of the aquifer is often referred to as the Garber-Wellington Aquifer. The recently acquired TAC area (former GM plant) obtains water from the City of Oklahoma City. Surrounding communities originally tapped the Central Oklahoma Aquifer, but today obtain water primarily from surface sources. The Hennessey group contains some saturation known colloquially as the Hennessey Water-bearing Zone, which overlies the Upper Saturated Zone across the southwest portion of the base; this water-bearing zone is not part of the Central Oklahoma Aquifer.

Approximate direction of groundwater flow in the Garber-Wellington Aquifer is south and southwest across the southern one-half of Tinker AFB and west to northwest across the northern one-half. Shallow groundwater may discharge to surface streams (gaining stream) or be recharged by streams (losing stream). Both situations occur at Tinker AFB along Crutcho Creek and Soldier Creek. In contrast, water in the Hennessey Water Bearing Zone generally flows to the northeast toward Crutcho Creek from higher topographic areas along the south boundary of Tinker AFB.

Most water from the Garber-Wellington Aquifer is of sufficient quality to be used for most industrial, agricultural, and domestic purposes. However, some contaminated groundwater plumes do exist, typically at a depth of 175 feet or shallower. These plumes are primarily a result of aircraft maintenance and overhaul operations that occurred between the mid-1940s and mid-to-late-1970s. These operations required the use of solvents and involved activities such as chrome plating which by various means led to contaminants entering ground water. Leaking fuel tanks and inappropriate waste disposal practices also contributed to the plumes.

Groundwater plume contamination does not pose health concerns at this time since the producing zone (i.e., depth at which water from supply wells is obtained) is 200 feet or deeper. Also, there appears to be an aquitard at approximately 200 feet, which hydraulically separates the producing zone from shallower groundwater in the aquifer.

2.3 Ecosystems and the Biotic Environment

2.3.1 Ecosystem Classification

The United States Environmental Protection Agency (EPA), 2005, places most of Tinker AFB in the Central Great Plains ecoregion (mixed-grass prairie), with some eastern fringe areas in the Crosstimbers ecoregion

Bailey (2014) classifies the TAFB ecosystem within the Humid Temperate Domain, Prairie Division, Prairie Parkland (Subtropical) Province. Prairies are typically associated with continental, mid-latitude climates designated as subhumid.

2.3.2 Vegetation

2.3.2.1 Historic Vegetative Cover

The pre-settlement floral community on land currently occupied by Tinker AFB was considerably different from the existing community. Likely two primary vegetation types existed—rolling mixed-grass prairie and oak savanna (see figure, "Tinker AFB Pre-settlement Vegetation").

Tinker AFB Pre-settlement Vegetation: Rolling mixed-grass prairie bisected by wooded bottomlands as shown in this picture is believed to be similar to most of Tinker AFB property prior to settlement.

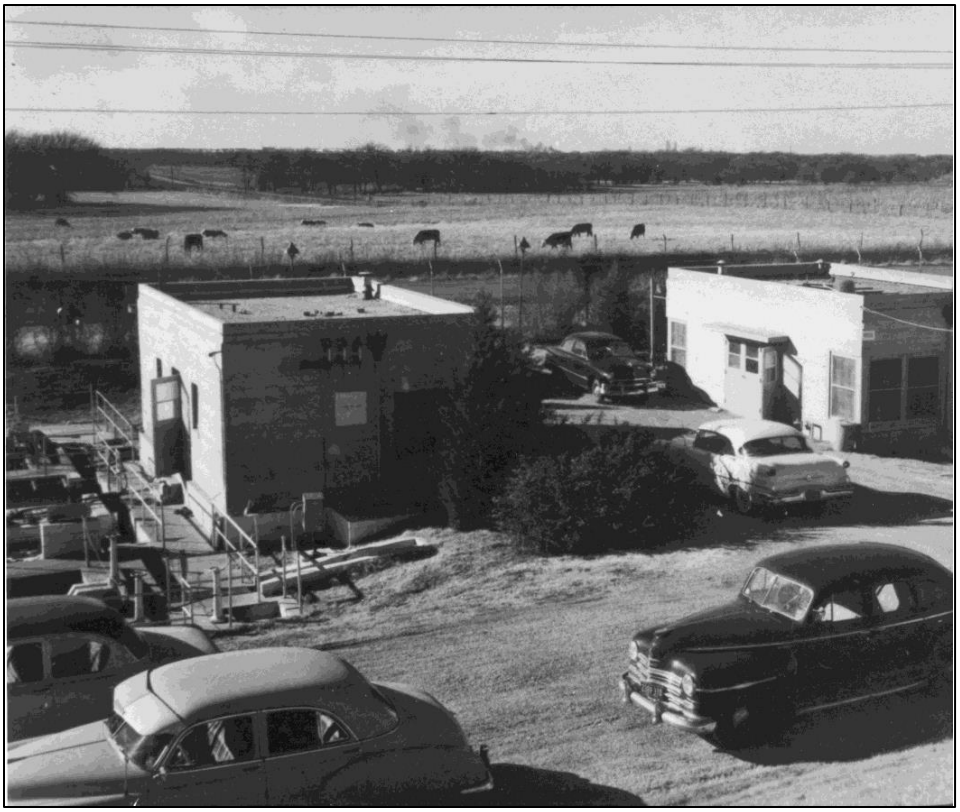
West of Building 3001, the majority of Tinker AFB appeared to be covered by mixed-grass prairie with trees and shrubs, if they existed, occurring almost exclusively in bottomland areas along watercourses. In the early 2000s, one of the oldest trees (bur oak) on Tinker AFB was aged at 100 to 110 years old. This indicated it began growing about the time of the Oklahoma land run. This could imply there were no trees in the water courses on land currently occupied by Tinker AFB prior to settlement—wildfires may have been of a frequency that trees could not become established. Then, when the land was settled, trees were more protected from wildfires creating conditions such that from that time forward they became established and survived to present day. Alternatively, settlers may have removed trees for building materials and firewood, but new trees began growing at that time and survived until today.

Additional implications can be drawn from recent tree growth in previously mowed bottom land areas. In 1990, mowing was discontinued in the floodplain area of Crutcho Creek between Air Depot Blvd and the Urban Greenway entrance. Native tree species that emerged from the floodplain seed bank included green ash, bur oak, slippery elm, soapberry, sugarberry, black walnut, Kentucky coffeetree, persimmon, cottonwood, black willow, Osage orange, redbud, boxelder, eastern red cedar, and American elm. Dominant trees were green ash and elm. Exotic trees that emerged were lacebark elm, Siberian elm, and callery pear. If trees did historically occur, or intermittently occur, along the Crutcho and Kuhlman watercourses, many of these trees (excluding the exotics) were likely present.

It appears most plausible that, for the most part, a treeless, rolling mixed-grass prairie is the true representation of the pre-settlement floral community for land areas west of Building 3001. It is believed oak savanna and/or denser crosstimber vegetation occurred in the upland areas east of Building 3001 and on the east side of Glenwood (where soil association transitions occur and post oak remnants are present). This is believed to be the dividing line between the aforementioned Central Great Plains and Crosstimbers ecoregions.

Tinker's vegetation represents an ecotone between the eastern deciduous forest and the western grasslands. Tallgrass species, such as big bluestem, indiangrass, and switchgrass were probably more dominant in draws and bottomland areas where soils were deeper and more fertile. Species such as little bluestem, gramas, and buffalo grass likely would have been more prevalent on the dryer slopes and crests of hills. In the bottomland areas, possible dominant woody tree species would have been elm, ash, sugarberry, hackberry, oak, walnut, cottonwood, and willow. Possible dominant woody shrubs would have included sumac, false indigo, corralberry, lead plant, green brier, roughleaf dogwood, and buttonbush. This grassland ecosystem was maintained by natural events and processes such as native mammal grazing, fire, flooding, and the climate of the local region. Bison and prairie dogs historically played significant roles in native grassland ecosystems.

Less than 2% of the pre-settlement prairie ecosystem currently remains on Tinker AFB. No pristine native prairie or bottomland areas are present on the installation. Very few, small, fragmented prairie remnants currently occur on Tinker AFB. These remnants total less than 100 acres and are in a degraded condition; restoration activities are currently ongoing on some of these areas. Much of the original prairie was farmed as evidenced by historical aerial photographs and remaining farmland terraces at numerous locations on Tinker AFB. Livestock grazing (see figure, "Tinker AFB Land Use") also appears to have been a significant past agricultural practice as seen by extant barbed wire fencing. Past grazing is also apparent by the absence of some plant species which would be expected to be present on existing prairie remnants had livestock grazing not occurred.



Tinker AFB Land Use: Cattle grazing in the 1950s on land formerly occupied by the 3rd Combat Communications Group (looking west, original Air Depot Boulevard can be seen between Sanitary Treatment Plant buildings and cattle).

Further native vegetation community change has occurred due to historical natural events, such as fire and herbivory, being removed from these prairie ecosystems. Thus, these islands of prairie habitat have been invaded by woody and non-native herbaceous plant species.

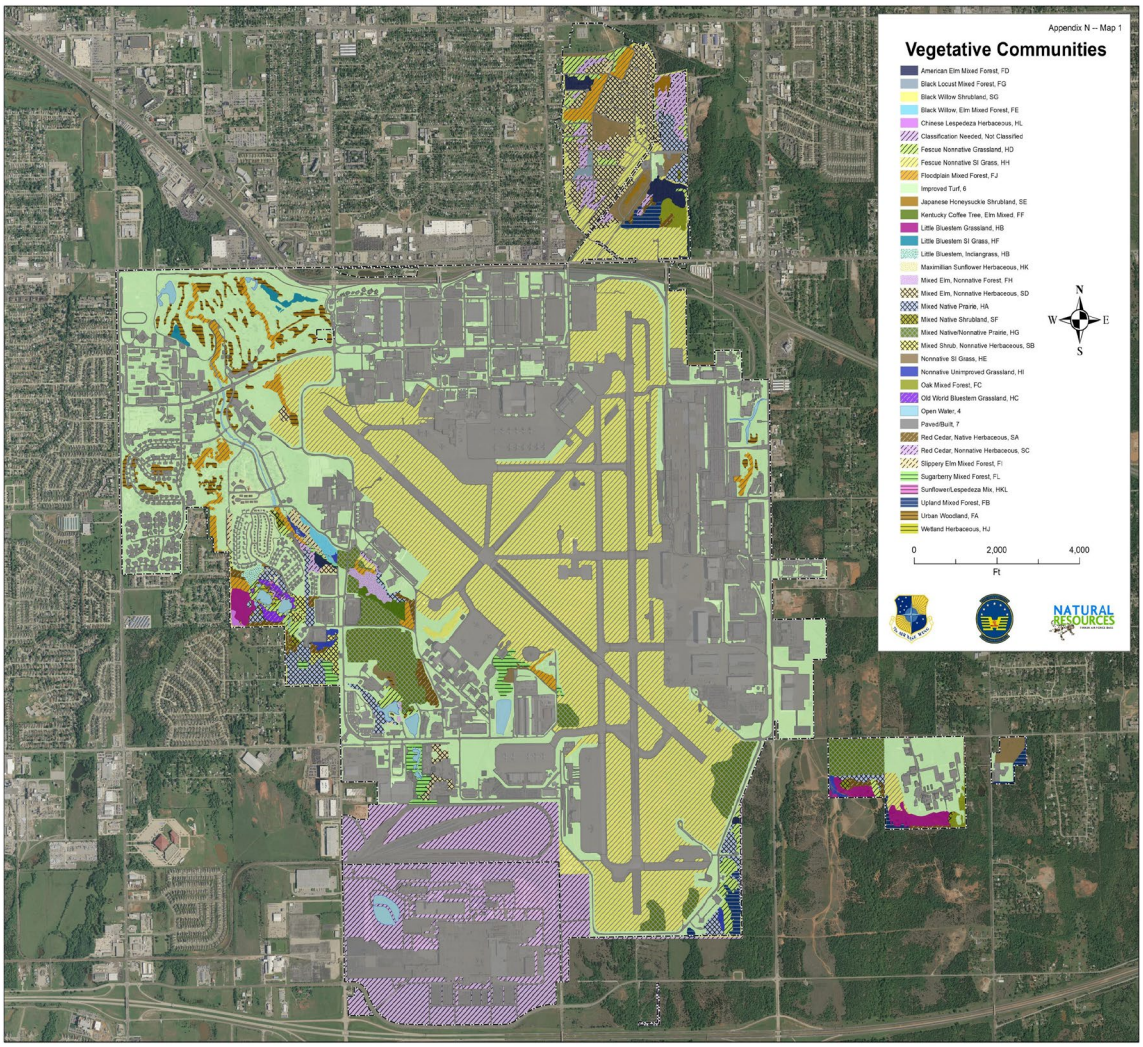
Bottomland areas have been substantially altered by activities such as channelization, native riparian vegetation removal, mowing, fire suppression, flood regime alteration, and exotic species invasion/introduction. Also, urban activities have caused soil properties to change substantially over the years, consequently modifying the original plant community. Common soil disturbances include topsoil being removed and not replaced; exotic plant species being used to revegetate disturbed areas; and soil compaction resulting from off- road training exercises, military construction projects, past aircraft parking on airfield, and related activities.

Within land areas which have been converted to urban and industrial use, the plant community is comprised primarily of turf grasses and ornamental trees and shrubs. The predominant turfgrass on Tinker AFB is exotic Bermuda grass. Native buffalograss is often found mixed with Bermuda grass. Other more rural areas are typically a mixture of exotic and native plants. Trees and shrubs are composed of native and exotic plants, and, contrary to pre-settlement plant distribution, many woody plants are found on upland as well as bottomland sites.

2.3.2.2 Current Vegetative Cover

Various vegetation surveys have been conducted at Tinker AFB since the early 1990s. A basewide flora inventory was completed in 1993 (Glenn et al., 1993). This survey catalogued Tinker's floristic community to include a herbarium collection maintained in the Natural Resources office (Flora List Appendix C). A native tallgrass prairie assessment was conducted in 1995 to determine the status and trend of native prairie areas on Tinker AFB (Johnson et al., 1995). This assessment determined that there was very little (less than 100 acres) native tall/mixed grass prairie remaining on Tinker AFB, and that which did remain was in degraded condition because of invasion of woody species, declining vigor of the native grasses, and the presence of a few exotic plant species. A base-wide vegetation classification and communities cover map was completed in 2005 (Dorr, et al. 2005; see figure "Tinker AFB Vegetation Communities Map" and table, "Vegetation Communities"). This provided current information regarding the composition of vegetation communities and their distribution within the boundaries of Tinker AFB.

An urban forest inventory was completed in 2007 (Dorr, et al. 2007) and is discussed further under the Urban Forestry section. From these surveys, approximately 388 plants have been identified on Tinker AFB.



Tinker AFB Vegetative Communities Map

Vegetative Communities: These communities have been identified and used for mapping vegetation at Tinker AFB.

Vegetation Community	Total Hectares
Urban Woodland (code FA)	18.5
Mixed Non-native Semi-improved Grass (code HE)	14.2
Little Bluestem (*Schizachyrium scoparium*) Semi-improved Grassland (code HF)	2.5
Mixed Native/Non-native SI Prairie (code HG)	49.6
Fescue (*Lolium* spp.) Non-native SI Grass (code HH)	422.7
Upland Mixed Forest (code FB)	8.1
Oak (*Quercus* spp.) Mixed Forest (code FC)	15.4
American Elm (*Ulmus americana*) Mixed Forest (code FD)	6.5
Black Willow (*Salix nigra*), Elm (*Ulmus* spp.) Mixed Forest (code FE)	2.2
Kentucky Coffee Tree (*Gymnocladus dioicus*), Elm (*Ulmus* spp.) Mixed Forest (code FF)	2.0
Black Locust (*Robinia pseudoacacia*) Mixed Forest (code FG)	1.1
Mixed Elm (*Ulmus* spp.), Non-native Forest (code FH)	3.1
Slippery Elm (*Ulmus rubra*) Mixed Forest (code FI)	3.1
Floodplain Mixed Forest (code FJ)	23.2
Sugarberry (*Celtis laevigata*) Mixed Forest (code FL)	8.0
Native Herbaceous, Redcedar (*Juniperus virginiana*) Shrubland (code SA)	14.9
Non-native Herbaceous, Mixed Shrubland (code SB)	3.8
Non-native Herbaceous, Redcedar (*Juniperus virginiana*) Shrubland (code SC)	14.5
Non-native Herbaceous, Mixed Elm (*Ulmus* spp.) Shrubland (code SD)	34.4
Japanese Honeysuckle (*Lonicera japonica*) Strangled, Mixed Shrubland (code SE)	1.7
Mixed Native Shrubland (code SF)	2.2
Black Willow (*Silax nigra*) Shrubland (code SG)	1.7
Mixed Native Prairie (code HA)	32.0
Little Bluestem (*Schizachyrium scoparium*) Grassland (code HB)	10.6
Old World Bluestem (*Bothriochloa ischaemum*) Non-native Grassland (code HC)	2.2
Fescue (*Lolium* spp.) Non-native Grassland (code HD)	16.0
Mixed Non-native Unimproved Grassland (code HI)	2.7
Wetland Herbaceous (code HJ)	0.5
Maximilian Sunflower (*Helianthus maximilianii*) Mixed Herbaceous (code HK)	0.3
Chinese Lespedeza (*Lespedeza cuneata*) Non-native Mixed Herbaceous (code HL)	0.5
Sunflower/Lespedeza Mix (code HKL) Needs To Be Classified	0.04 100.5
Total:	818.7*

*Total hectares do not include 1036 hectares that were identified as Paved/Built, Open Water, or Improved Turf

Effects of Climate Change on Vegetation

As relates to climate change, increased seasonal, annual, minimum, and maximum temperatures and changing precipitation patterns could impact Tinker vegetation. Slight changes in temperature and precipitation can substantially alter the composition, distribution, and abundance of species, and the products and services they provide. The extent of these changes will also depend on changes in the frequency and intensity of fire.

Increased drought frequency could also cause major changes in vegetation cover. Losses of vegetative cover coupled with increases in precipitation intensity and climate-induced reductions in soil aggregate stability could dramatically increase erosion rates.

In general, forests, which comprise a small portion of base land, are susceptible to climate change. Higher temperatures and severe droughts could lead to the direct or indirect loss of trees on Tinker.

2.3.2.3 Urban Forestry

For purposes on Tinker AFB, urban forest is defined as primarily street and park trees that are located on improved and semi-improved grounds (i.e., grounds that are routinely mowed) to include privatized military family housing. Trees located in unimproved grounds (e.g., Glenwood area, riparian areas) or that occur as groupings with natural understory vegetation are a part of the urban forest but are considered and managed as "tree stands," not as individual trees.

A base-wide urban forest inventory was completed in 2007 (most field work in summer 2006). The inventory identified and evaluated over 6,600 street trees across the installation. Data collected in the GIS-based survey included species, age class, hazard class, maintenance needs, and other information (Dorr, et al., 2007). As of 2017, the base has an estimated 5,091 street trees.

For Tinker AFB urban forest management policy and guidance, refer to Appendix G (Tinker AFB Urban Forestry Management Procedures) and Section 7.7, Grounds Maintenance.

2.3.3 Fish and Wildlife

History

Approximately 350 native vertebrate species and a much greater unknown number of invertebrates have historically occurred either in the Central Oklahoma/Texas Plains or Central Great Plains Ecoregions (Oklahoma Biodiversity Task Force, 1996). A smaller number occurred on land currently occupied by Tinker AFB. Some species which likely occurred on this land during pre-settlement times include prairie dogs, bear, bison, wolves, elk, and horses. Fossilized bison mandibles and horse teeth have been unearthed on Tinker AFB property confirming the historical presence of these species on Tinker AFB.

In general, although some urban-tolerant fish and wildlife populations have increased on Tinker AFB, overall species diversity has declined from pre-settlement times. Human activity and noise levels have increased, thereby deterring more sensitive species from occurring. Some species requiring large tracts of undisturbed land have been displaced because of habitat loss in the area. Intense urban development on Tinker AFB has attracted urban adapted wildlife such as non-native house sparrows, European starlings, and pigeons. These species have often out competed and displaced native species. Introduction of other non-native animals, such as feral cats, has to some degree negatively affected native wildlife.

Wildlife populations have been impacted further by intentional removal or relocation of certain wildlife. For example, egret and heron rookeries have occasionally colonized near Tinker AFB. These birds have often migrated daily across Tinker AFB causing aircraft flight safety concerns. Therefore, habitat at rookeries was modified during the non-breeding season to dissuade future nesting. This led to birds nesting at other locations away from Tinker AFB. Other species, such as the thirteen-lined ground squirrel, are believed to have been extirpated from Tinker AFB; human-wildlife conflicts such as burrowing on the golf course resulted in their removal over the years.

Fish and wildlife migration has also been negatively impacted by development. In-stream structures such as box culverts, check dams, and spill control structures impede the free movement of fish in Tinker AFB creek systems. However, recent stream studies have indicated that some of these in-stream features (i.e., check dams and spill control gates) have provided deeper pools and have enhanced fish populations (Marsh-Matthews, Matthews and Moody, 2010). Terrestrial wildlife movement patterns have been disrupted by fragmentation of historically contiguous habitat. Fencing around the entire installation, as well as interior fencing around the airfield and other restricted access areas, has further influenced the movements of larger wildlife.

Roadway wildlife kills are another negative urban impact on wildlife. Because of relatively low speed limits on Tinker AFB, roadway wildlife kills are believed to be less than off-base roadway systems. Although not believed to be a major problem on Tinker AFB, it is recognized that roadway kills must be taken into consideration, particularly when dealing with sensitive species. For example, road kills of the Texas horned lizard have been documented on Tinker AFB. This, along with other factors, could contribute to the decline of this species particularly in areas where prime habitat is adjacent to busy roadways.

Although there are no known early historical (pre-1980s) fish inventories for the Tinker AFB, numerous changes to the area stream systems and water quality issues have certainly had negative impacts on aquatic biota of the area (refer to Hydrology section for discussion of stream system impacts which would have affected aquatic biota).

Occurrence of over 330 native and exotic vertebrate species has been documented on Tinker AFB property (see Appendix D, "Fauna List"). This includes resident and migratory populations and is comprised of 40 mammals, 212 birds, 35 reptiles, 12 amphibians, and 33 fish (includes two hybridized fish). Tinker's species list has been compiled through inventory-related work such as recent class specific fish inventories: Investigating the Stream Fishes of Tinker Air Force Base (Lemons and Moody, 2005) and Fishes Assemblages of the Crutcho Creek Drainage Basin (Marsh-Matthews and Moody, 2010). Several other class specific wildlife inventories have been completed which include: Reptile, Amphibian, and Mammal Assemblages on an Urban Military Base in Oklahoma, (Bogosian, Hellgren and Moody, 2011); Bat Echolocation Surveys on Tinker AFB (Shaw and Moody, 2013-14 and CIRE et al., 2016); and Inventory of Avian Species on Tinker AFB, (Germain, 2010). Several invertebrate surveys have been conducted with 128 species being identified, including 36 aquatic macroinvertebrates identified and assessed by Virginia Tech University (2010) and 24 species of ants identified in conjunction with Texas horned lizard surveys. Furthermore, a volunteer hobbyist/entomologist has devoted many hours to surveying and identifying invertebrate species on Tinker AFB. Several of these surveys go beyond basic inventory and address important management issues for specific species such as the Texas Horned Lizard (research conducted by Southern Illinois University (SIU), see section on Sensitive Species). Other non-class specific surveys have included bird/wildlife aircraft strike hazard (BASH) surveys, sensitive species surveys, fish kill investigations, in-house deer spotlight surveys, and incidental observations by program biologists.

Much of Tinker's wildlife is found along riparian corridors and upland area habitat (see figure, "Habitat Favorable to Wildlife Movement and Habitation" in Section 7). Many of these areas are connected with off-base habitat and represent important animal refugia and movement corridors.

Mammals

Common mammal (class *Mammalia)* species on Tinker AFB include fox squirrel (*Sciurus niger*), eastern cottontail rabbit (*Sylvilagus floridanus*), opossum (Didelphis virginiana), raccoon (*Procyon lotor*), bobcat (*Felis rufus*), coyote (C*anis latran*), beaver (*Castor canadensis*), muskrat (*Ondatra zibethicus*), white-tailed

deer (*Odocoileus virginianus*), various rodent species (*Peromyscus* sp., *Neotoma* sp., *Sigmodon* sp., etc.), and others.

One species-specific study on Tinker AFB was for the thirteen-lined ground squirrel (*Spermophilus tridecemlineatus*) (CH2MHILL, 1998), conducted to determine its presence or absence. This study was done following verbal reports of historic occurrences on the golf course along with concerns of declining populations in the state. This survey consisted of identification of appropriate habitat (i.e., shortgrass prairie and managed areas with vegetation <14"), subsequent visual observations, and live trapping. Approximately 1,655 acres of potential habitat were identified and surveyed using baited Sherman live-traps. While no ground squirrels were captured, three other rodent species were: hispid cotton rat (*Sigmodon hispidus*), deer mouse (*Peromyscus maniculatus*), and short-tailed shrew (*Blarina brevicauda*).

Twenty-five of 36 different mammal species known to occur on Tinker AFB were identified in surveys conducted by SIU in 2007-08, the University of Science and Arts of Oklahoma (USAO) in 2013-14, and the Center for Integrated Research on the Environment (CIRE), et al., 2016. The remaining 11 mammals were identified by incidental observations by base biologists and the ground squirrel survey mentioned above.

In the SIU survey, the base was divided into 16 study areas based on either natural or man-made geographic features. Several indicator species (see table, "Species Survey" in Section 7.1) were selected based upon conservation need in the Oklahoma Crosstimbers and Mixed-grass ecoregions (Oklahoma Department of Wildlife Conservation, 2005). Using a variety of sampling techniques, 2,000 individual mammals were captured or observed. Species richness and diversity were predictably higher within green space portions of the base and notably lower near Tinker's airfield and industrial areas (see table, "Species Survey" in Section 7.1). These results are similar to surveys conducted on other military installations (Camp Mabry and Fort Wolters, Texas) in the region. Data are in agreement with published records of high diversity and presence of species of considerable conservation interest on military installations.

The USAO and CIRE surveys targeted bat species using echo-location monitors. Monitors were positioned at five different locations along riparian systems and at one location on top of Building 240. Calls were recorded for two week intervals throughout the summers of 2013, 2014, and 2016, resulting in the confirmation of nine bats on Tinker AFB (see Appendix D, "Fauna List").

Reptiles and Amphibians

Reptiles (class *Reptilia*) comprise families consisting of snakes, turtles, and lizards; amphibians (class *Amphibia*) include frogs, toads, and salamanders. See Appendix D, "Fauna List", for Tinker's reptile and amphibian inventory.

Forty-seven reptile species have been identified on Tinker AFB to include the three-toed box turtle (*Terrapene carolina*), red-eared slider (*Trachemys* [*Pseudemys*] *scripta*), prairie racerunner (C*nemidophorus sexlineatus*), northern prairie lizard (*Sceloporus undulates garmani*), western slender glass lizard (*Ophisaurus attenuates attenuatus*), plain-bellied water snake (*Nerodia erythrogaster*), and Texas horned lizard (*Phrynosoma cornutum*). Only one venomous reptile—copper head (*Agkistrodon contortrix*)—has been confirmed on Tinker AFB. There have been several copperhead sightings east of Douglas Blvd., to include the Cyber Installation Engineering Group (CEIG) campus. It is expected copperheads would occur in the extreme southeast corner of the installation near the Munitions area.

Twelve amphibians (8 frogs, 3 toads, and 1 salamander) have been identified on Tinker AFB to include the American bullfrog (*Rana catesbeiana*), gray tree frog (*Hyla versicolor*), Plains leopard frog (*Rana Blairi*), Woodhouse's toad (*Fufo woodhousei*), and smallmouth salamander (*Ambystoma texanum*).

Although most reptiles and amphibians on Tinker AFB are common, some species, such as the Western chorus frog (*Pseudacris triseriata*) and Texas horned lizard (*Phrynosoma cornutum*), are species of conservation concern.

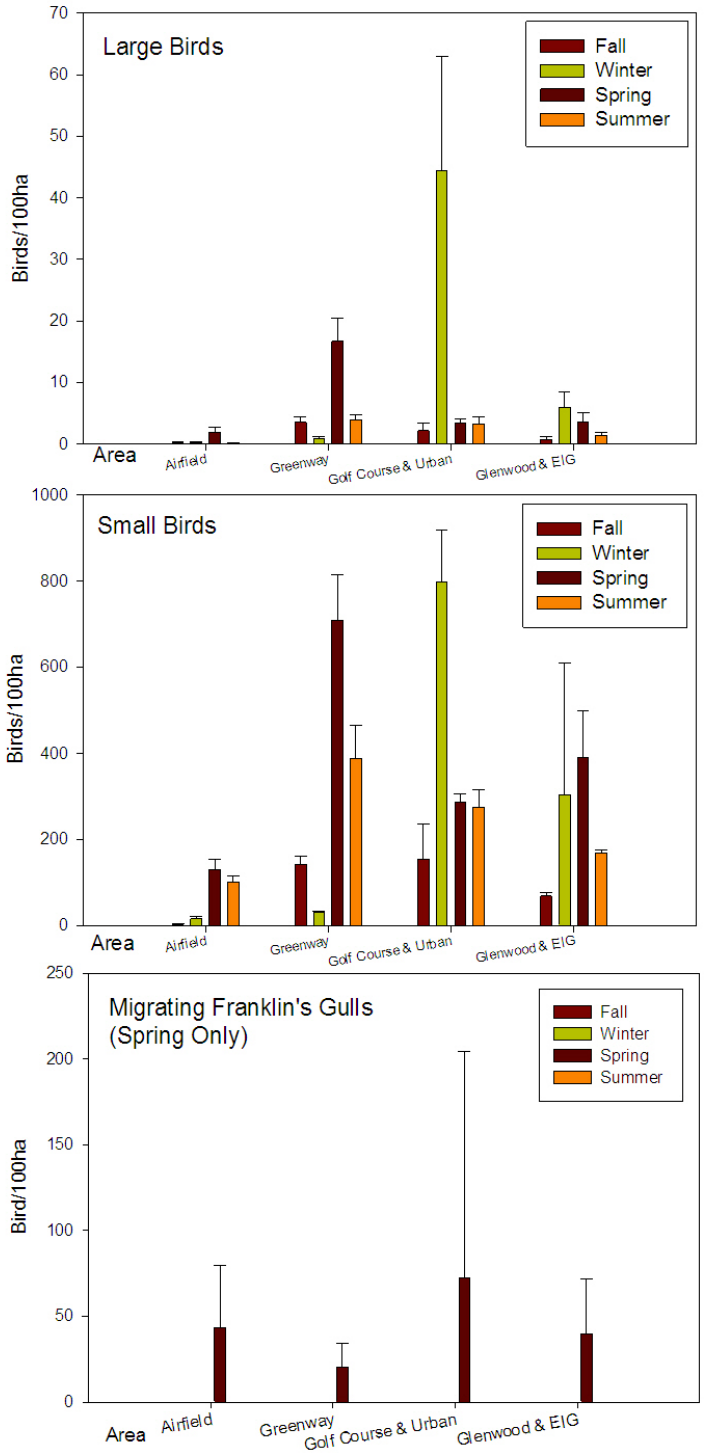
Twenty-six of the 36 different reptile species and 11 of the 12 different amphibians were identified in a class-specific survey conducted by SIU in 2007 and 2008 (Bogosian, Hellgren and Moody, 2011). Other sightings occurred during research being conducted on the Texas horned lizard. The horned lizard has been studied in detail on Tinker AFB under partnerships with the University of Oklahoma, Oklahoma State University (OSU) and SIU. Details of this research are in the Sensitive Species section.

Birds

Oklahoma is rich in diversity and abundance of bird (class *Aves)* life with over 400 species occurring in the state (Wood and Schnell, 1984). Many of these species are found on and around Tinker AFB. A significant source for the large diversity of bird life comes from Tinker's location on the central flyway where thousands of migratory birds traverse Oklahoma each year.

Biologists have documented 213 bird species on Tinker AFB through class and non-class specific surveys (Appendix D, "Fauna List"). The class specific survey, Inventory of Avian Species on Tinker Air Force Base (St. Germain, 2010), was conducted by Virginia Tech Conservation Management Institute. This study documented 137 of the 213 species. Other bird sightings have been incidental in nature, with most coming from individual sightings by Tinker AFB biologists, BASH surveys, or baseline surveys conducted for environmental assessments. Most of the birds identified are common such as species featured in George Miksch Sutton's work, Fifty Common Birds of Oklahoma and the Southern Great Plains (Sutton, 1977); however, many less common birds occur.

Results of the St. Germain study (St. Germain, 2010) showed spring had the highest diversity base-wide with 107 (species richness) followed by summer (68) and fall (56). The top six most abundant birds were eastern meadowlark 0.30 (relative abundance - ra), Franklin gull 0.179 (ra), European starling 0.108 (ra), mourning dove 0.042 (ra), northern cardinal 0.042 (ra), and barn swallow 0.041 (ra) (see figure, "Density Estimations"). Simpson's Diversity Index and species evenness (Krebs 1999) were calculated for each survey area by season. Diversity ranges from 0 (low diversity) to near 1 (high diversity).



Density Estimations: Based upon size classes for each region and season, migrating Franklin's gulls were calculated separately from all other species detected due to large flock sizes in winter.

Invertebrates

Oklahoma is rich in abundance and diversity of both aquatic and terrestrial invertebrates. Mollusks are among these, numbering over 201 species, and include 111 terrestrial snails and slugs, 31 aquatic snails, and 59 bivalves (clams and mussels). Terrestrial arthropods (insects, spiders and ticks) dominate by sheer numbers and diversity and are critical to ecosystem functioning. Scientists estimate there are over 200,000 insect species in North America, and Oklahoma is expected to have approximately 10,000 with its ecoregion diversity (Oklahoma Biodiversity Task Force, 1996). This task force identified the need for more sampling and taxonomic expertise throughout the state.

Invertebrate species serve many ecologically critical roles. Thus, to gain a better understanding of these animals, Tinker AFB biologists have embarked on several methods of identifying their presence on base. First, an Aquatic Benthic Macroinvertebrate Assessment was conducted for Tinker's ponds and streams by Virginia Tech (Jones and St. Germain, 2010). Secondly, Tinker AFB began preserving a voucher collection of invertebrate species. This has primarily been done through the volunteer efforts of a proven hobbyist entomologist (John E. Lee) who has provided species identification and preservation expertise. Staff biologists have also contributed to the collection documenting unique Tinker AFB species. Finally, in conducting research on Texas horned lizard diet preferences, many (24) Tinker AFB ant species have been identified. In total, 129 invertebrate species and members of various invertebrate families have been identified (see Appendix D, "Fauna List").

No invertebrate species at risk (SAR) have been identified on Tinker AFB; however, several vulnerable invertebrates listed by the Xerces Society and the International Union for Conservation of Nature (IUCN) are found in Oklahoma and potentially in central Oklahoma including Tinker AFB. According to the Xerces Society, these include the Arogos skipper (*Atrytone arogos*), Monarch Butterfly (*Danaus plexippus plexippus*), and Ottoe skipper (*Hesperia ottoe*). The skippers have not been identified on Tinker AFB; however, the Monarch, which is under review for listing as a federal threatened/endangered species, does migrate through the base. In one fall migration during the early 2000s, the number of Monarchs was so high the airfield bird watch condition was elevated to "Severe" due to safety concerns associated with the possible ingestion of butterflies into aircraft engines. Some Monarchs also have been observed completing their life cycle in base natural areas (Urban Greenway, Reserve 3). Species listed on the International Union for Conservation of Nature (IUCN) Red List of Threatened Species that are known to occur on Tinker AFB are *Bombus fraternus* (endangered) and *Bombus pensylvanicus* (vulnerable).

The Oklahoma Natural Heritage Inventory (ONHI) does not list any invertebrate species of concern for Oklahoma County (ONHI, 2011).

Fish

Tinker AFB fishes (class *Osteichthyes*) within the Crutcho Creek Drainage Basin (CCDB) have been influenced by urbanization due to its metropolitan location and its headwaters being on a military installation. Urbanization is known to have negative effects on fish assemblage structure and species richness (Tabit and Johnson, 2002). However, native fish species that have evolved under harsh physical and chemical conditions may be more tolerant of urbanization than species that have evolved in more benign conditions (Matthews, 1987). Few studies have been published concerning effects of urbanization on prairie stream fishes or of the patterns of fish assemblages on Air Force bases (Marsh-Matthews and Matthews, 2010).

One peer-reviewed, published survey (Matthews and Gelwick, 1990) documented 17 fish species within non-Tinker AFB CCDB waters. Other more recent, unpublished, non-Tinker AFB fish data collected by

Lemmons and Vidacovich (2005) and Marsh-Matthews and Matthews (2010) shows 22 species inhabit the CCDB off-base (see figure, "Fish Survey Collection Sites"). Tinker AFB records indicate that 31 species of fish (see Appendix D, "Fauna List") have been identified in Tinker AFB ponds, streams, and wetlands. There are also several hybridized species and species strains that occur on Tinker AFB, such as the bluegill x redear sunfish (*Lepomis macrochirus* x *microlophus*) and rosy-red fathead minnow (*Pimephales promelas* 'Golden Strain'). In addition, several different species have been stocked as part of recreational sport fishing programs.

Fish Survey Collection Sites: Matthews, Marsh-Matthews, and Moody site sampling locations in 5 comparator streams along the North Canadian River for 2009 and 2010. TAFB is located in boxed portion of drainage basin.

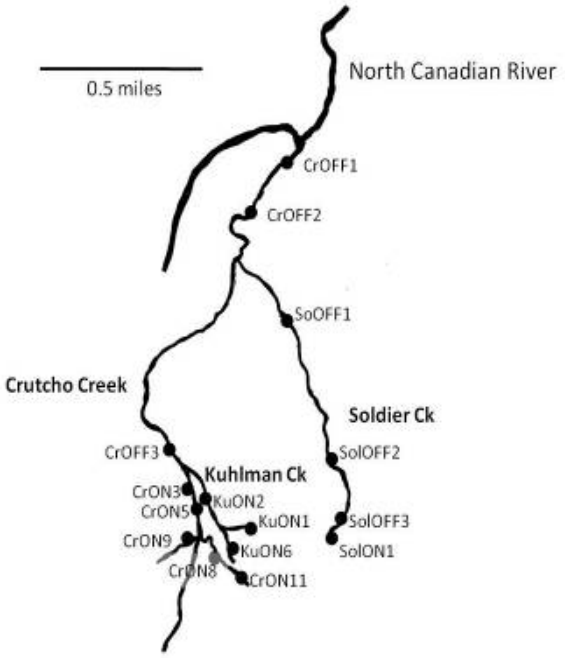
Historically, many Tinker AFB fish species were identified through sport fisheries management surveys, sporadic seining of streams, and fish kills. More recently however, class-specific surveys have been conducted for comparisons of fish in the entire CCDB, including Tinker AFB properties. The first of these surveys was started in 2005 by Lemmons and Moody. This comprehensive seasonal stream survey collected 4,732 individuals representing 20 species for the five sampling periods between August 2004 and June 2005.

At the end of the 2005 sampling period, researcher Lemons was unable to complete the survey. Thus, the survey was continued under cooperative agreement with the University of Oklahoma in 2009 by Marsh-Mathews, Mathews and Moody (2010).

Collection efforts and numbers of species collected increased from 2003 to 2011 within the CCDB (Lemmons and Moody, 2005 and Marsh-Mathews and Mathews, and Moody, 2010). Though earlier records of lower stream diversity, derived partly from significant total fish kill events in stream segments, are likely accurate and reflective of fish assemblages prior to 2003. Matthews and Gelwick (1990) survey of Crutcho Creek indicated lower species richness than what currently occurs in Crutcho Creek. In this early study, the two closest sampling locations (i.e., on Crutcho Creek just off Tinker AFB and at Soldier Creek at the convergence with Crutcho Creek where stream type and conditions were similar to on-base segments), had only 12 species present in collections. This is very similar to on-base historical records of 10 to 13 species being present in the early 1990s (e.g., Tinker AFB records). Matthews also indicated that game fish were rare, and piscivores, such as largemouth bass, were notably absent from their collections. Though suitable physical habitat for such piscivore species existed in the stream. Conversely, collections from Lemons and Moody (2005) had a species richness of 21 species, and all 12 of the species that were present in the 1990 study were found except for blue tilapia (*Tilapia aurea*). Numerous piscivorous species were also found during 2003-2005 including: largemouth bass (*Micropterus salmoides*), white crappie (*Pomoxis annularis*), channel catfish (*Ictalurus punctatus*), and spotted gar (*Lepisosteus oculatus*), all of which were not present in the 1990 study with the exception of channel catfish.

Particularly of note was the presence of spotted gar at two sites in the basin, on-base at Crutcho Creek and off-base in Soldier Creek (approximately 1 mile from convergence with Crutcho Creek). This represented a range extension for the spotted gar in the North Canadian River drainage basin (Miller and Robinson, 2004).

Most recently, the Marsh-Mathews, Mathews and Moody (2010) survey has collected 20 species from 4,732 individuals in nine different sites on Tinker AFB (see figure, "Fish Sampling Sites") and a total of 22,574 individuals of 25 species in the Crutcho Creek Drainage Basin. Additionally, 16 different off-base comparison streams were surveyed in order to assess Tinker AFB fish assemblage health. A total of 65,206 individuals were collected and 29 species were represented. The most abundant species found in the CCDB are very similar to those found in comparator streams (see table, "Most Common Fish Species"). In addition, the Lemmons and Moody survey (2005) found longear sunfish (*Lepomis megalotis*), red shiner (*Cyprinella lutrensis*), sand shiner (*Notropis stramenius*), fathead minnow (Pimephales promelas), and green sunfish (Lepomis cyanellus) dominated numerically. There were also numerous piscivorous species taken in these two studies such as the largemouth bass (*Micropterus salmoides*), white crappie (*Pomoxis annularis*), and spotted gar (*Lepisosteus oculatus*). These species were notably absent in the pre-1990 surveys. The most diverse (i.e., 14 species identified) sampling location on Tinker AFB within Crutcho Creek was CrON9, a segment just north of the historical Spaatz Dr. (i.e., road has been removed). This is likely the most natural creek segment and closest to pre-settlement conditions having a riparian canopy and little stream channel alteration. Diversity of fish species and richness in this segment is comparable to fish assemblages of similar Great Plains prairie streams (Matthews and Gelwick 1990).



Fish Sampling Sites: Eight Tinker AFB site sampling locations in the Crutcho Creek Drainage Basin and four off base. Site designations include the creek name abbreviations, number, and on/off base position.

Most Common Fish Species

Most Common Species Found in Crutcho Creek Drainage Basin and Comparator Streams			
Common Name	**Scientific Name**	**Proportion of Individuals Collected CCDB**	**Proportion of Individuals Collected Comparator Streams**
Red shiner	*Cyprinella lutrensis*	0.372	0.656
Sand shiner	*Notropis stramineus*	0.219	0.073
Golden shiner	*Notemigonus crysoleucas*	0.123	-
Longear sunfish	*Lepomis megalotis*	0.105	0.058
Bullhead minnow	*Pimephales vigilax*	0.061	0.066
Fathead minnow	*Pimephales promelas*	0.052	0.017
Bluegill sunfish	*Lepomis macrochirus*	-	0.032
Green sunfish	*Lepomis cyanellus*	0.029	-
Western mosquitofish	*Gambusia affinis*	0.018	0.058
Bluntnose minnow	*Pimephales notatus*	-	0.018

* Data 2009-2010 from Marsh-Matthews, Matthews and Moody (2010) study "Fishes of Crutcho Creek Drainage Basin"
- Indicates that proportion was below 1% but still found in collections

As part of these two studies (Lemmons and Moody, 2005 and Marsh-Mathews, Mathews and Moody, 2010), temporal patterns were statistically analyzed using Jaccard's index (JI) and percent similarity index (PSI) following methodology used by Matthews (1998). Analysis of species collected at all Crutcho Creek basin sampling sites showed qualitative similarity with JI ranging from an average 0.423 to 0.851 for all pair-wise comparisons between sampling dates. Mean JI of the averages was 0.621, indicating that overall the Tinker AFB Crutcho Creek system had a high degree of stability (Matthews 1998). Mean PSI averaged 0.754, which revealed that the permanent sampling sites had a high degree of similarity between sampling dates based on relative abundance of species. PSI was also calculated for the latest round of sampling (2009- 2010) for all CCDB sites and comparator sites and indicated a similar high score of 0.667. Matthews (1998) considers a PSI above 0.50 indicative of stable fish assemblage. Un-weighted pair-group using arithmetic means, cluster analysis, and detrended correspondence analysis was conducted on values confirming the results of PSI and JI analysis. Upon completion of these studies, results indicated fish assemblages in the Tinker AFB Crutcho Creek system are stable and similar to many other Mid-western fish assemblages (Lemmons and Moody, 2005 and Marsh-Mathews, Mathews and Moody, 2010).

Community ecology has been theorized and developed over many years and is necessary to the understanding and management of native communities both in prairies and streams. Leopold (1949-53) in his conservation classic, "Sand County Almanac", proclaimed that,"For the biotic community to survive, its internal process must balance, else its member-species would disappear." While this being foundational in ecology, the entire process and concepts have yet to play out. Over the early years, community ecology dynamics and concepts have developed from species-specific competition leading to stability (Gause, 1937 and Elton, 1946) to "resource partitioning" (Hardin, 1960) leading to balanced equilibrium to "fundamental niche" and "n-dimensional hypervolume" (Hutchinson, 1957) with many resource axes. Debate continued in more recent history over

"equilibrium vs. non-equilibrium" as it became better understood how stream communities fluctuate over time and in response to multiple variables and extreme events like floods and droughts (Grosman et.al., 1982 and Ross et.al., 1985). As a result of this progression and long-term fish studies, more modern fish community theory has taken on approaches of multivariate analysis such as stability and similarity indexes to describe fish communities as applied in Marsh-Matthews, Mathews and Moody (2010). While from these analyses Tinker's streams were determined to be "stable and similar", to other mid-western streams with new concepts in community ecology this description may fall short. Therefore, the base is continuing study efforts on Tinker streams in long-term studies with Marsh-Matthews and Matthews et.al., (2013, 2015 and 2016) to determine if Tinker's fish community falls within a proposed "Loose Equilibrium Concept" (LEC) as described in Matthew's book "Stream Fish Community Dynamics, a Critical Synthesis" (2017). These study efforts will provide a picture of fish community dynamics and natural variation in Tinker streams as a baseline for detecting fish community changes in the future, allowing recommendations for management and restoration of fish communities.

Effects of Climate Change on Fish and Wildlife

Fish and wildlife communities at TAFB are not expected to experience significant changes due to climate change. A substantial proportion of TAFB is developed, and most wildlife species on post are widespread generalists such as fox squirrels, eastern cottontails, opossums, raccoons, rodents, gray tree frogs, red-eared sliders, sunfish and minnows. Generalist wildlife species can tolerate a wide range of environmental conditions. Increasing temperatures at TAFB under all climate scenarios are not likely to impose direct threats to most of the wildlife species, but does raise concerns for indirect threats.

Migrating birds are an important and diverse component of wildlife communities found on the installation and may be especially vulnerable to indirect threats. Many birds time their migration routes to coincide with the springtime emergence of insects. Rising temperatures will prompt insects to emerge earlier, and birds migrating to or through TAFB could miss a major feeding opportunity that could result in decreased bird populations (Both et al., 2010). Long term changes in insect emergence could also change bird migration timing.

Changing climate also has the potential to alter vegetation communities, and these changes could have a negative impact on specialist fish and wildlife species that have historically depended on specific native plant communities for their survival (Dukes & Mooney, 1999).

Changing environmental conditions may also create open niches for non-native invasive species to expand onto TAFB. Newly arriving invasive species often have the ability to outcompete native species which are already experiencing reduced fitness due to environmental conditions shifting away from historic standards (Hellmann, Byers, Bierwagen, & Dukes, 2008). For example, if increased temperatures persist, red-imported fire ant populations could permanently surge northward across the state of Oklahoma causing catastrophic harm to native ant populations. This in-turn could negatively impact sensitive species on Tinker such as the Texas horned lizard, whose primary diet is native ants.

Rising temperatures could also result in the increased potential for foodborne diseases and incidences of infectious diseases of animals that are transmittable to humans, particularly those carried by foxes, rodents and arthropods such as rabies and West Nile virus (Parkinson & Butler, 2005).

Precipitation is projected to increase slightly but will possibly be offset by higher evapotranspiration rates due to increasing temperatures. Higher air temperatures can negatively impact water quality, particularly in lentic systems. As water temperatures rise in lentic systems, dissolved oxygen content decreases, impairing water quality particularly for larval amphibians and aquatic macroinvertebrates. Increasing water temperature can also increase the chances of algal blooms occurring, further depleting dissolved oxygen

content and degrading habitat quality (Paerl, Hall, & Calandrino, 2011). This could be of particular concern in areas on Tinker such as the golf course ponds which have historically experienced algal blooms.

While projections for annual precipitation forecast small increases in precipitation, summers are expected to become drier. Droughts will likely be more common, reducing water availability for fish and wildlife communities and increasing likelihood of wildland fires. Such shifts in environmental conditions could have particularly negative impacts on specialist or less common wildlife species such as bobcats, coyotes, beavers, muskrats and whitetail deer (Hellmann et al., 2008).

2.3.4 Threatened and Endangered Species and Species of Concern

Flora

No flora on Tinker AFB is classified as state or federal species of concern or proposed/listed as threatened or endangered. However, one rare species, the Oklahoma penstemon (*Penstemon oklahomensis*), does occur on Tinker AFB (see figure, "Oklahoma Penstemon in Full Bloom").

Oklahoma Penstemon in Full Bloom

Tinker AFB natural resources biologists use several web-based resources to assist in managing endangered, threatened, candidate, rare, and other sensitive flora species:

- Oklahoma Natural Heritage Inventory (ONHI) Plant Tracking List (2014)
  http://www.biosurvey.ou.edu/download/publications/NEWtrackinglist02212014.pdf
- Rare and Vulnerable Plant Species of Oklahoma (2011)
  http://www.oknaturalheritage.ou.edu/plants_rare_vulnerable.htm

The ONHI, a program administered by the state Oklahoma Biological Survey (a research unit of the University of Oklahoma), establishes and maintains lists of Oklahoma flora species based on their rarity. ONHI gives species and natural communities occurring in Oklahoma two ranks: a global (G) rank reflecting its rarity throughout the world, and a state (S) rank reflecting its rarity within Oklahoma. ONHI rarity rankings have no regulatory stature; however, this information has been included to aid Tinker AFB biologists in developing and prioritizing species and natural community management objectives. The following table (see table, "Oklahoma Natural Heritage Inventory (ONHI) Rare Flora") lists species that have been documented as occurring on Tinker AFB.

Oklahoma Natural Heritage Inventory (ONHI) Rare Flora

Common Name	Scientific Name	Global	State
Oklahoma penstemon	*Penstemon oklahomensis*	G3*	S3
Global Rank*			
G1	Critically imperiled globally because of extreme rarity (5 or fewer occurrences or very few remaining individuals or acres) or because of some factor of its biology making it especially vulnerable to extinction.		
G2	Imperiled globally because of its rarity (6 to 20 occurrences or few remaining individuals or acres) or because of other factors demonstrably making it vulnerable to extinction throughout its range.		
G3	Either very rare and local throughout its range or found locally (even abundantly at some of its locations) in a restricted range, or because of other factors making it vulnerable to extinction throughout its range; in the range of 21 – 100 occurrences.		
G4	Apparently secure globally, though it may be quite rare in parts of its range, especially at the periphery.		
G5	Demonstrably secure globally though it may be quite rare in parts of its range, especially on the periphery.		
State Rank			
S1	Critically imperiled in Oklahoma because of extreme rarity (5 or fewer occurrences or very few remaining individuals or acres) or because of some factor of its biology making it especially vulnerable to extinction.		
S2	Imperiled in Oklahoma because of extreme rarity (6 to 20 occurrences or few remaining individuals or acres) or because of other factors making it very vulnerable to extinction throughout its range.		
S3	Rare and local in Oklahoma (though it may be abundant at some of its locations); in the range of 21-100 occurrences.		
S4	Apparently secure in Oklahoma.		
S5	Demonstrably secure in Oklahoma.		

The Oklahoma penstemon is endemic to Oklahoma and north Texas and is found at several locations on Tinker AFB (see figures, "Historic Locations of Penstemon Colonies"). The penstemon is located in fragmented remnant native prairie communities, primarily in the southeast portion of Tinker AFB to include the airfield, Cyber Engineering Installation Group (CEIG, formerly EIG), leased land immediately adjacent to and south of Landfill 6. Another small population occurs in the northeastern portion of Glenwood.

The Oklahoma penstemon occurs only in Oklahoma and north Texas and is thus classified as rare globally. This species, also referred to as Oklahoma beardtongue, is a perennial cool-season forb that typically blooms in late April to early May. It is found in mixed native prairie and mixed native/non-native prairie areas on Tinker AFB. A large portion of the penstemon colonies on Tinker AFB are found on disturbed, non-native vegetation types.

Historical Locations of Penstemon Colonies (Glenwood)

Historical Locations of Penstemon Colonies (S.E. Portion of Tinker AFB)

Fauna

Tinker AFB natural resource biologists use several published resources to assist in managing endangered, threatened, candidate, rare, and other sensitive fauna species:

- U.S. Fish and Wildlife Service IPaC Trust Resource Report (2017)— Endangered and Threatened Species and Birds of Conservation Concern *https://ecos.fws.gov/ipac/*
- Oklahoma Natural Heritage Inventory Tracking List of Rare Oklahoma Vertebrates (2014-15) *http://www.oknaturalheritage.ou.edu/*
- NatureServe (2011) *http://www.natureserve.org/explorer/servlet/NatureServe?init=Species*

- Oklahoma Department of Wildlife Conservation (ODWC) Oklahoma Species List: Federally-listed, Proposed, Candidate, and Species Under Review (2017) *http://www.wildlifedepartment.com/wildlifemgmt/endangeredspecies.htm*

The following list is a compilation of documented and potential sensitive species on Tinker AFB. The table indicates their appropriate designations as threatened, endangered, or species of concern (S1, S2), or other designations. For sighting locations refer to "Species at Risk (SAR) Preferred Habitat Layer" in Section 7.4.

Species of Special Concern: Wildlife Species of Special Concern for Oklahoma County and Surrounding Tinker AFB Area.

Species of Concern in Oklahoma County (Wildlife)			
Common Name	**Scientific Name**	**Category**	**Observed on Tinker**
Federally Listed T & E Species			
Black-capped vireo	*Vireo atricapillus*	E	N
Least tern	*Sterna antillarum*	E	N
Townsend's big-eared bat (likely 'austrialis' Western sub species)	*Corynorhinus towsendii*	E	C?
Whooping crane	*Grus Americana*	E	N
Piping plover	*Charadrius melodus*	T	Y
Red knot	*Calidris canutus rufa*	T	N
Other Species of Concern			
Bald eagle	*Haliaeetus leucocephalus*	BGEPA	Y
Adler flycatcher	*Empidonax alnorum*	S2	Y
American avocet	*Recurvirostra Americana*	S2	Y
American bittern	*Botaurus lentiginosus*	S1S3	Y
American golden-plover	*Pluvialis dominica*	BCC	Y
Baltimore oriole	*Icterus galbula*	S2S4	Y
Bank swallow	*Riparia riparia*	S2	Y
Black-bellied plover	*Pluvialis squatarola*	S2	Y
Black vulture	*Coragyps atratus*	S2	Y
Bobolink	*Dolichonyx oryzivorus*	S2	Y
Burrowing owl	*Athene cunicularia*	S2	Y
Canada warbler	*Wilsonia canadensis*	S1	Y
Chestnut-sided warbler	*Denroica pensylvanica*	S2	Y
Chicken turtle	*Deirochelys reticularia*	S2	Y
Common poorwill	*Phalaenoptilus nuttallii*	S2	Y

Cooper's hawk	*Accipiter cooperii*	S2	Y
Dunlin	*Calidris alpina*	S2	Y
Green heron	*Butorides striatus*	S2	Y
Harris sparrow	*Zonotrichia querula*	BCC	Y
Hooded warbler	*Wilsonia citrina*	S2	Y
Horned grebe	*Podiceps auritus*	S2	Y
Lesser yellowlegs	*Tringa flavipes*	BCC	N
Little brown bat	*Myotis lucifugus*	S1	Y
Long-billed curlew	*Numenius americanus*	BCC	Y
Long-eared owl	*Asio otus*	S1	Y
Magnolia warbler	*Dendrocia magnolia*	S2	Y
Marbled godwit	*Limosa fedoa*	BCC	N
Migrant loggerhead shrike	*Lanius ludovicianus migrans*	S2,SG	Y**
Mountain bluebird	*Sialia currucoides*	S2	Y
Osprey	*Pandion haliaetus*	S2	Y
Ovenbird	*Seiurus aurocapillus*	S2	Y
Red-breasted nuthatch	*Sitta Canadensis*	S2	Y
Red-headed woodpecker	*Melanerpes erythrocephalus*	BCC	Y
Sandhill crane	*Grus canadensis*	S2	Y
Semipalmated sandpiper	*Calidris pusilla*	BCC	Y
Snowy plover	*Charadrius alexandrines*	GC	Y
Spotted sandpiper	*Actitis macularia*	S1S3	Y
Whip-poor-will	*Caprimulgus vociferus*	S2	Y
Silver-haired bat	*Lasionycteris noctivagans*	S2	Y
Smith's longspur	*Calcarius pictus*	BCC	N
Swamp sparrow	*Melospiza georgiana*	S2	Y
Texas horned lizard	*Phrynosoma cornutum*	CS, S2,SG	Y
Townsend's solitaire	*Myadestes townsendi*	S2	Y
Tree swallow	*Tachycineta bicolor*	S2	Y
Virginia rail	*Rallus limicola*	S1	Y
Whimbrel	*Numenius phaeopus*	S1	Y
Whip-poor-will	*Caprimulgus vociferus*	S2	Y
Willet	*Tringa semipalmata*	BCC	Y

Yellow-bellied flycatcher	*Empidonax flaviventris*	S2	Y

S2 or S1 - Species of Concern (state ranking). These species have been identified by technical experts as critically imperiled and possibly threatened of extirpation but for which additional information is needed (Oklahoma Natural Heritage Inventory).

SG – Species of Greatest Conservation Concern (Tier I) as identified in Oklahoma Comprehensive Wildlife Conservation Strategy (2016).

CS - Statewide closed season (state ranking). It is unlawful at any time to possess or to kill individuals of these species or to remove any individuals of these species from their natural habitats.

T - Threatened Species Federal listed. This species has been listed by technical experts as threatened of extirpation.

E - Endangered Species Federal listed. This species has been listed by technical experts as endangered of extirpation.

BCC – Birds of Conservation Concern listed by the USFWS IPaC Report 2018 for Tinker AFB Surrounding area

BGEPA – Bald and Golden Eagle Protection Act list by USFWS IPaC Report 2017

UC – Field identification unconfirmed with echolocation recordings

C? – *Corynorhinus townsendii* identified through echolocation recordings but Western vs. Ingens, endangered subspecies not confirmed

** Shrikes (*Lanius ludovicianus*) do occur on Tinker AFB, with the migrant race (i.e., *migrans*) potentially occurring.

Revised 29 March 2018

Based on the above sources, there are six federally listed threatened and endangered species that could potentially occur on base. Only one, the piping plover (*Charadrius melodus*), has been documented on base. This plover was found dead on Runway 36/18 on 11 May 2009, the result of a bird-aircraft strike. U.S. Fish and Wildlife Service (USFWS) and Oklahoma Department of Wildlife Conservation (ODWC) officials were contacted, and the plover was sent to verify identification. No other piping plovers have been observed loafing or foraging on Tinker AFB property before or after this strike. Three other threatened and endangered species—the least tern (*Sterna antillarum*), red knot (*Calidris canutus rufa*), and whooping crane (*Grus americana*) are listed by the USFWS IPaC Report as potentially occurring in the Tinker AFB area but have not been observed on or flying over Tinker AFB. Two additional listed species that may potentially occur on or near Tinker AFB are the Black-capped vireo (*Vireo atricapillus)* and the Townsend's big-eared bat (*Corynorhinus towsendii* 'ingens'). The bat was identified as potentially occurring through echolocation monitoring by the University of Montana. However, their recordings couldn't verify whether the calls were from the Western 'australis' or the Ozark 'ingens' subspecies which is listed. The "ingens" subspecies range is limited to eastern Oklahoma and western Arkansas and therefore outside its typical range (Piaggio and Perkins 2005). In addition the USFWS has indicated that the Western 'australis' species is likely the subspecies that was recorded and would be more likely to be found on Tinker AFB (letter from USFWS, May 2020). Habitat for the Black-capped vireo is absent on the base, so its presence is unlikely. It should also be noted that Bald Eagles protected under the Bald and Golden Eagle Protection Act (16 U.S.C. 668) frequent Draper Lake in the winter months and have been observed feeding and hunting on the lake.

The USFWS IPaC Report also lists 9 species of birds as "Birds of Conservation Concern" potentially occurring in the Tinker AFB area. Of these, 6 have been identified on Tinker AFB. Thirty-eight State Species of Special Concern have been identified on the base.

2.3.5 Wetlands and Floodplains

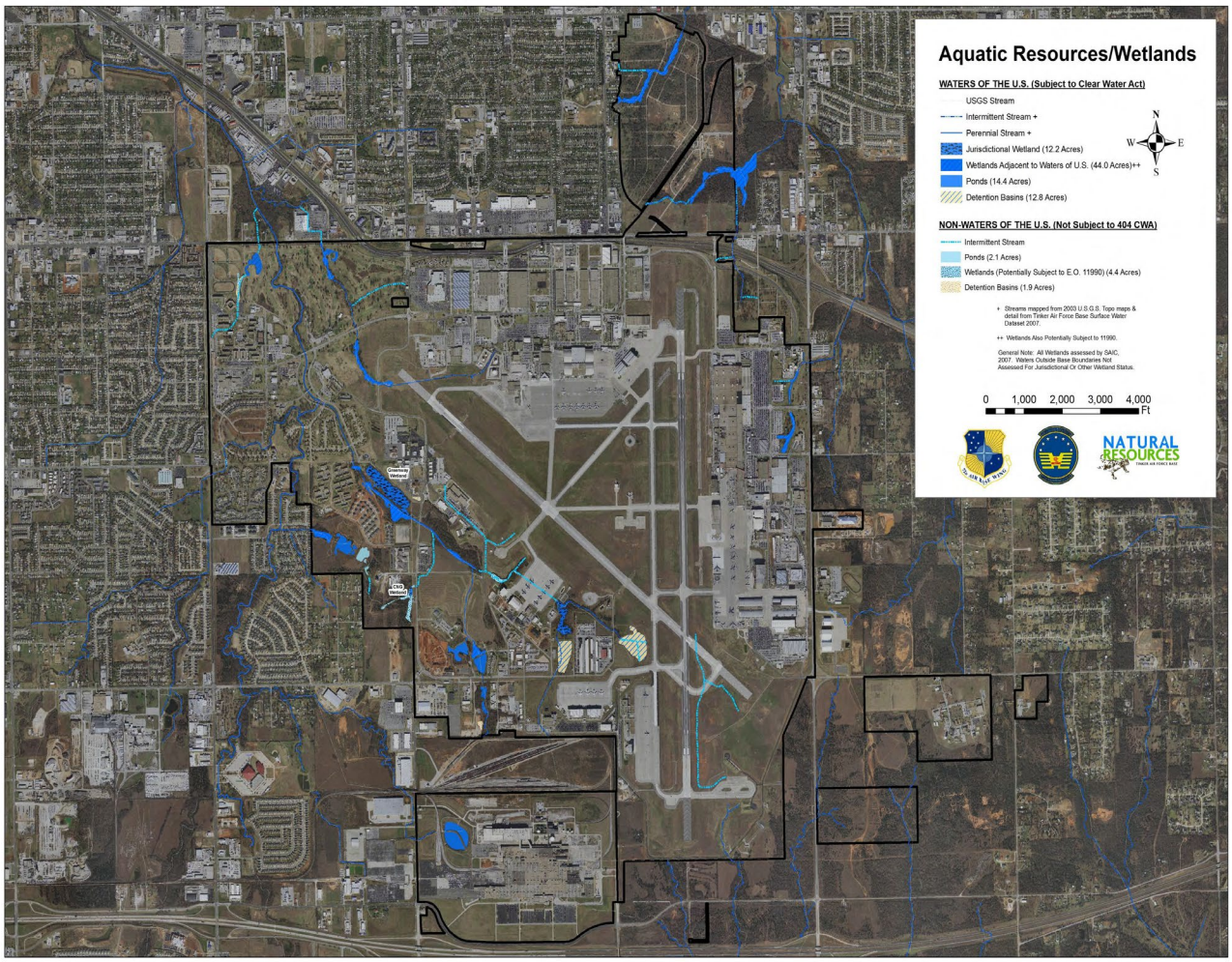
Wetlands

In 1995, approximately 65 wetland acres were identified on Tinker AFB by the U.S. Fish and Wildlife Service (USFWS) using National Wetland Inventory (NWI) criteria. This included creeks, ponds, drainage swales, and other wet areas.

Of the original 65 acres identified using NWI methodology, five wetland areas: 1) the Ground Water Treatment Plant (GWTP) Wetland (0.63 acres); 2) Fuel Control Facility Wetland (0.8 acres); 3) Greenway Wetland (8.64 acres); 4) Compressed Natural Gas (CNG) Wetland (0.34 acres); and 5) the Glenwood Wetland (1.5 acres, on-base portion only) were classified by the U.S. Army Corps of Engineers (USACE) as jurisdictional wetlands under the Clean Water Act. An additional contiguous off-base portion (8.5 acres) of the Glenwood wetland, which was located immediately east of Tinker AFB on county and private land, was also classified as jurisdictional.

During wetland monitoring in 2007, Science Applications International Corporation (SAIC) identified another jurisdictional wetland below and north of Fire Detention Pond (SAIC, 2008). This wetland likely developed from improper sizing of drainage pipes under the 507th ramp, which caused water to routinely back up into this wooded area. All jurisdictional wetlands on Tinker AFB were man-made with the exception of the Glenwood wetland, which was created by beaver.

Aquatic Resources (Wetlands) of Tinker AFB: Jurisdictional and non-jurisdictional wetlands on Tinker AFB (includes jurisdictional status of Tinker surface waters).



Floodplains

Tinker's 100- and 500-year floodplain boundaries were updated by the U.S. Army Corps of Engineers in 2002 (USACE, 2002) (see figure, "Tinker AFB Floodplains"). The 100- and 500-year floodplains combined comprise approximately 462 acres (100-year = 426.74 acres; 500-year = 35.55 additional acres). The majority of the floodplain, with the exception of Reserve 1 within the Urban Greenway is classified as improved grounds (i.e., facilities, roads, ramps, or highly maintained areas such as lawns, athletic fields, golf course, where personnel perform intensive maintenance). Much of the floodplain is therefore in an altered and impaired condition.

Effects of Climate Change on Flooding

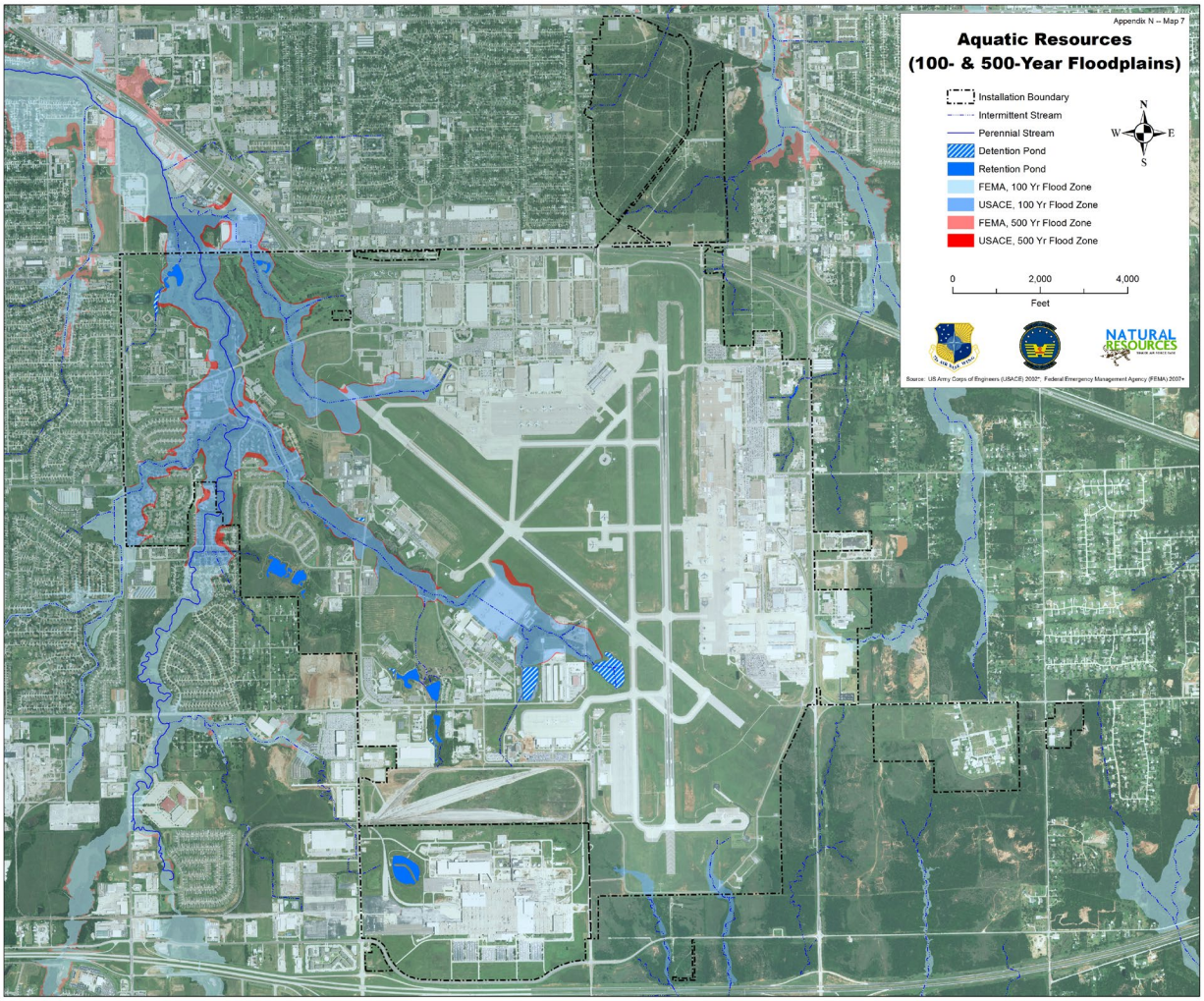
Associated with climate projections, modeling of stream channel overflow (or flood modeling) was conducted along Crutcho Creek in 2019 to examine the extent of flooding. Flood modeling was conducted using local watershed characteristics and the design storms generated from climate projection data. Floodplain modeling did not consider flooding of independent surface bodies, stormwater systems, or surface ponding. The projected design storms do not represent extreme weather events (e.g., hurricanes, extraordinary storm fronts). Inundation projections were influenced by four variable inputs: (1) variation in total precipitation between design storms, (2) variation between the daily distribution of precipitation over the three-day period, (3) land cover change over the watershed area used in hydrologic modeling, and (4) land cover change in the area within the installation used in hydraulic modeling.

Projected inundation associated with each climate scenario and the relative change from baseline conditions are summarized in table, "Projected Inundation from Stream Channel Overflow". In 2030, stream channel overflow is under the RCP 4.5 emission scenario is projected to not change from baseline conditions while under the RCP 8.5 emission scenario, inundation is projected to decrease by 15%. In 2050, inundation is projected to increase by 16% under the RCP 4.5 scenario but decrease by over 70% under the RCP 8.5 scenario. Land cover over the Crutcho Creek watershed is projected to be dominated by woodland/forest under the RCP 8.5, 2050 climate scenario, affecting runoff and inundation estimates.

The spatial extent of projected flooding is depicted in a series of maps included in Tab 8, Appendix C. In 2030, stream channel overflow is under the RCP 4.5 emission scenario is projected to not change from baseline conditions while under the RCP 8.5 emission scenario, inundation is projected to decrease by 15%. In 2050, inundation is projected to increase by 16% under the RCP 4.5 scenario but decrease by over 70% under the RCP 8.5 scenario. Land cover over the Crutcho Creek watershed is projected to be dominated by woodland/forest under the RCP 8.5, 2050 scenario, affecting runoff & inundation estimates.

Projected Inundation from Stream Channel Overflow

	Baseline	RCP 4.5		RCP 8.5	
	2000	2030	2050	2030	2050
Projected inundation (acres)	190.3	190.3	221.1	161.4	51.6
Change in inundation area from baseline (acres)		0	30.8	-28.9	-138.7
Percent change from baseline		0%	16%	-15%	-73%



Tinker AFB Floodplains: 100- and 500-year floodplain delineations and associated streams for Tinker AFB and adjacent communities (USACE, 2002)

2.3.6 Other Natural Resource Information

This section is reserved for other miscellaneous natural resources management information as needed.

2.4 Mission Impacts on Natural Resources

2.4.1 Natural Resource Constraints to Mission and Mission Planning

Currently, the primary potential natural resources constraint to future development and mission expansion on Tinker is flooding. As development continues on and off base, and if forecasted climate changes materialize, particularly the 2050 RCP 4.5 scenario, the quantity and intensity of flooding events on Tinker are anticipated to increase. This would negatively impact Tinker's mission, damaging much infrastructure. And, if Tinker expands into flood zones, unmitigated, it would exacerbate flooding impacts on downstream

off-base communities such as Midwest City. Therefore, proper floodplain management is essential. Execution of Tinker's Green Infrastructure Plan counters this threat and will ensure the military mission is resilient and not hampered by future flood events.

Other potential future climate-related impacts to the Tinker mission include:

- unsafe environmental conditions for the launch of current and planned weapons and equipment, resulting in increased maintenance requirements, need for new equipment, or decreased launch capacity due to increased temperatures and wind velocities (DoD, 2014);
- disruption in underground utility services due to pipe damage caused by expanding/contracting clay soils as the result of increased temperatures and droughts;
- increased dust generation effecting equipment and visibility due to high winds (DoD, 2014);
- damaged infrastructure due to increased wind velocities (Sydeman et al., 2014);
- potential degradation of realistic training sites due to loss of certain vegetation types;
- difficulty in cooling Information Transfer Node Systems (ITNS) due to high temperatures;
- reduced production due to tightened work-rest regimes caused by high temperatures;
- damage to infrastructure such as asphalt roadways due to high temperatures and droughts;
- disruption to field training due to invading fire ants caused by warmer temperatures
- disruption to military activities caused by the listing of species such as the Texas horned lizard as threatened or endangered (due to expansion of fire ant population which could negatively impact the lizard population regionwide).

In addition to these direct effects, climate change has the potential to disrupt the acquisition and transportation of materials required for the maintenance, construction, and storage of the equipment required for these systems (DoD, 2014).

Another potential natural resources-related impact that could restrict or complicate Tinker's future flying mission is the proposed development of West Elm Creek Reservoir immediately adjacent to the west of Lake Stanley Draper. If this reservoir were built, bird/wildlife aircraft strike hazards would be expected to rise.

2.4.2 Land Use

Tinker AFB is approximately 90% developed. Refer to Grounds Maintenance Land Use Classification map in Section 2.0 (Installation Profile) for general distribution of land uses.

2.4.3 Current Major Impacts

Prior to the construction of Tinker AFB, much of the land it presently occupies had been converted from native grassland to scattered farmsteads and agricultural land (e.g., farming and grazing). These new land uses significantly altered and degraded the area's natural resources and the functioning of natural systems. Subsequent military buildup and activities and surrounding off-base urbanization further impacted flora, fauna, soil, and water resources on and near the installation. In general, the most significant post-agricultural impact to natural resources on Tinker AFB has been the further displacement or degradation of native plant and animal communities as the result of facility/airfield development, noise, human activity, and other urban and industrial influences. Other impacts include the introduction of pollutants into the environment such as surface and groundwater, and disturbance of native soil conditions due to dense industrial and urban development.

Today, the majority of military operations and activities are conducted within facilities on the industrial portions of Tinker AFB as opposed to on the few remaining undeveloped land fragments. However, small

scale on-the-ground training is conducted in some undeveloped areas, primarily in the Glenwood Training Area. The Glenwood area is comprised of approximately 280 acres and is located off the end of the north-south runway. It was formerly a residential area, but because of aircraft safety concerns houses were removed in the 1970s. The roadways were left intact. Therefore, the native natural resources in Glenwood have been substantially disturbed. Only the southeast and northeast corners of the area have remained undeveloped. Current activities in the Glenwood area consist primarily of ground troop skills training and war exercises such as firefights and convoy training. These involve the use of foxholes and mock munitions such as smoke canisters and ground burst simulators. Other field training includes orienteering courses, major accident response exercises, search and rescue training, and local municipality police department pursuit training. Most of the vehicular training is conducted on established paved roadways. Impacts to natural resources by these activities are primarily related to wildlife which would be impacted by noise and the presence of troops and vehicles. However, considering the previous residential disturbance to the area prior to Tinker AFB occupation, training in this area is believed to have relatively little additional impact on natural resources.

Early Construction of Tinker AFB: Farmland is rapidly converted to industrial and airfield land uses in the 1940s.

Early Construction of Tinker AFB: Establishment of farmland and subsequent construction of Tinker's airfield in 1941 led to almost complete removal of the original native prairie community.

Early Construction of Tinker AFB: Workers sprigging airfield with exotic Bermuda grass in 1941.

2.4.4 Potential Future Impacts

Future development on and surrounding Tinker AFB would, if not properly planned, negatively impact native floral and faunal communities. Habitat loss and fragmentation would decrease biodiversity. The

Tinker AFB Green Infrastructure Plan recommends where to develop and where not to develop so as to limit negative impacts to natural resources as land is militarized. This plan encourages similar development practices on off-base land adjacent to the base. Also, a strong mitigation program would lessen the impacts of development on natural resources (see appendix, "Mitigation Action Tracker," for past and ongoing mitigation efforts on Tinker). The Oklahoma Southeast Sector Plan and Tinker Installation Development Plan contain further information on future development patterns on and surrounding Tinker AFB.

2.4.5 Natural Resources Needed to Support the Military Mission

Soil resources are in many ways foundational to sustained military operations on Tinker AFB. Soil is used to build up and level ground to permit infrastructure development across Tinker AFB. Quality soil is particularly valuable in controlling erosion on sloped terrain. Proper management and soil use can lead to tremendous cost savings for Tinker AFB projects. For example, in the mid-1990s, clay was excavated from two locations on Tinker AFB and used to cap three on-base landfills. This saved $500,000 by reducing soil and hauling costs.

Additionally, excavated sites were developed into ponds within Tinker's Urban Greenway which have enhanced warfighter quality of life. Soil provides the primary medium for vegetation growth, a critical ecological and aesthetic function. Fertile, properly managed soils will grow suitable vegetation for the airfield environment, golf course, and other areas. Improper management of soil could lead to erosion which in-turn could result in water quality notices of violation, thereby restricting military operations on Tinker AFB.

Vegetation is connected to the military mission in many ways. By protecting and increasing the distribution of the Oklahoma penstemon, Tinker AFB is doing its part to ensure state penstemon populations stay healthy and thrive. Currently, penstemon-related land use restrictions on Tinker AFB are minimal. However, if the state penstemon population were to go into decline and the plant became a federally listed threatened or endangered species, restrictions on land use could become much more stringent. It behooves the military to keep these populations healthy, thereby precluding listing and keeping land available for military use.

Vegetation also provides sites for realistic training exercises such as at Glenwood. Vegetation provides free ecological services (such as water filtration and soil stabilization) and enhanced aesthetics. The base Urban Greenway improves quality of life for the warfighter and his or her family. For example, many families use the Greenway's natural backdrop for family photos. Refer to "Green Infrastructure Benefits" in the Green Infrastructure Plan appendix for additional information on the importance of Tinker's vegetation resources to the military mission.

Fish and wildlife also support the military mission by supporting airmen, their families, and guests. Fish provide for inexpensive, close-to-home angling. Wildlife provide outdoor opportunities such as wildlife viewing and photography. Wildlife also support future military missions in less apparent ways. For the last nine years, Tinker AFB has partnered with various universities, organizations, and agencies to conduct research and provide considerable information on morphology, behavior, demographics, and ecology of Texas horned lizards in an urban environment. This fosters informed management of the species on Tinker AFB, in Oklahoma, and across the lizard's range. Improved management, in turn, promotes more robust populations and lessens the likelihood of federal or state listing as a threatened or endangered species. Preventing the listing of species reduces or eliminates potential land use restrictions on private and government lands, including installations within the geographic range of the lizard. Development of translocation methodology could also provide a means for mitigation when loss of horned lizard habitat on

base is unavoidable. Mitigation measures could prove an important factor for survival of the lizard if current development trends continue. These measures would also be valuable tools for private and public entities that have unavoidable land use changes or activities within areas of horned lizard habitat.

Active community-wide involvement in the natural resources program can contribute to a stronger military. When the people of Tinker AFB and surrounding communities take pride and ownership in their natural resources, the natural environment will become the best it can be. Ultimately, a healthier environment will make for a healthier people which in-turn translates into a healthier and stronger support of our national defense.

3.0 ENVIRONMENTAL MANAGEMENT SYSTEM

The AF environmental program adheres to the Environmental Management System (EMS) framework and its "Plan, Do, Check, Act" cycle for ensuring mission success. Executive Order (EO) 13693, *Planning for Federal Sustainability in the Next Decade*; U.S. Department of Defense Instruction (DoDI) 4715.17, *Environmental Management Systems*; AFI 32-7001, *Environmental Management;* and international standard, ISO 14001:2004, provide guidance on how environmental programs should be established, implemented, and maintained to operate under the EMS framework.

The natural resources program employs EMS-based processes to achieve compliance with all legal obligations and current policy drivers, effectively managing associated risks, and instilling a culture of continuous improvement. The INRMP serves as an administrative operational control that defines compliance-related activities and processes.

Environmental Compliance Assessment and Management Program (ECAMP) Inspection

The Tinker AFB natural resources program has been routinely evaluated via internal and external ECAMP inspections to identify and correct deficiencies. Through Air Force self-inspection, ECAMP essentially provides a "snap shot" of Tinker's compliance, or lack of compliance, with federal, state, and local natural resources laws and regulations, executive orders, DOD/Air Force policies and instructions, and other requirements.

As part of the INRMP annual review, natural resources staff will conduct a Stage 2 self-inspection using federal, Air Force, and state ECAMP inspection protocols and other internal checklists as applicable to ensure compliance is maintained with the aforementioned regulatory requirements. Findings will be documented on the following form: "Tinker AFB Finding and Corrective Action Worksheet." Completed forms will be submitted to the Tinker ECAMP program manager who will notify the noncompliant/compliant organization, track corrective actions, and brief at Environmental, Safety, and Occupational Health (ESOH) and EMS cross-functional team meetings. Also, for identification and tracking purposes, findings will be listed in this section of the INRMP. As appropriate, corrective action plans will be incorporated into INRMP work plans or submitted as job orders/work requests for corrective action.

Finding NR-1 (2018): Out-of-play areas *targeted* for future prairie/woodland restoration in the Golf Course Environmental Management (GEM) Plan have been allowed to grow without any maintenance (e.g., periodic mowing). This has resulted in the establishment and spread of invasive species such as Siberian and lacebark elm trees. This is not consistent with federal Executive Orders 13112, Invasive Species, and 13751, Safeguarding the Nation from the Impacts of Invasive Species. If trees are permitted

to continue to grow, future removal will require significant financial expenditures. (Responsible organization: 72 FSS/FSCG—golf course)

Corrective Action: 72 ABW/CEIEC received Air Force funding in FY2019 to remove all invasive trees and restore the out-of-play areas back to native prairie. Conservation and golf course staff have scheduled this work to be executed between Sep 2019 and Sep 2023. Invasive Plant Control, Inc. initiated Phase 1 (cutting, treating, and chipping invasive trees) in Sep 2019. **(Finding Status: CLOSED 9 Nov 2019)**

Finding NR-2 (2018): 50 CFR 21 states that no person may take, possess, import, export, transport, sell, purchase, barter, or offer for sale, purchase, or barter, any migratory bird, or the parts, nests, or eggs of such bird without a permit. The Tinker natural resources function possesses migratory bird feathers, nest, and egg without the proper federal permit.

Corrective Action: All migratory bird feathers, nest, and egg were collected and delivered to the US Fish and Wildlife Service (USFWS) law enforcement office in Edmond, OK on 15 May 2018. These will be transferred to the USFWS Ecological Services Field Office in Tulsa or other conservation agency where they will be used for educational purposes. (Responsible organization: 72 ABW/CEIEC—natural resources function) **(Finding Status: CLOSED 15 May 2018)**

Finding NR-3 (2019): DoDI 4715.03 states, "…forest products shall not be given away, abandoned, carelessly destroyed, used to offset contract costs, or traded for services, supplies, or products, or otherwise improperly removed," and AFI 32-7064 states, "Do not give away, abandon, or destroy forest products with marketable value…Forest products may not be traded for goods or services nor used to offset contract costs associated with construction, land clearing, or other contracted activity."

Five known instances of improper reclamation of merchantable wood occurred on Tinker in 2019: 1) the Tinker grounds maintenance contractor (Trace) felled merchantable trees on the base and loaded them in roll-offs, where they were hauled off base and disposed at a landfill; 2) a contractor removed trees associated with new parking lot construction and did not transport them to the base Forest Product Staging area though required by Section 00720 specification; 3) Trace felled trees at B-9001 parking lot islands where the trees were partially pilfered by base employees; 4) storm-damaged trees are not being reclaimed and are being improperly stockpiled/staged for disposal at the Tinker golf course, and 5) processed firewood is being pilfered from the unsecured base forest product staging area west of Building 1156.

Corrective Action: TBD

4.0 GENERAL ROLES AND RESPONSIBILITIES

General roles and responsibilities that are necessary to implement and support the natural resources program are listed in the table below. Specific natural resources management roles and responsibilities are described in appropriate sections of this plan.

Office/Organization/Job Title (Listing is not in order of hierarchical responsibility)	**Installation Role/Responsibility Description**
Installation Commander	• Approves the INRMP • Certifies the annual review of the INRMP as valid and current; or delegates the certification of the review to the appropriate designee

Office/Organization/Job Title (Listing is not in order of hierarchical responsibility)	**Installation Role/Responsibility Description**
	• Provides appropriate funding and staffing to ensure implementation of the INRMP • Controls access to and use of installation natural resources • Signs Findings of No Practicable Alternative (FONPA) for actions within a wetland or 100-year floodplain • Signs cooperative agreements entered into pursuant to the Sikes Act, 16 USC § 670c-1
AFCEC Natural Resources Media Manager/Subject Matter Expert (SME)/ Subject Matter Specialist (SMS)	• AFCEC Natural Resources Media Manager (TAFB)—Christopher White (provides base-level support to ensure natural resources program execution in accordance with the Sikes Act and other regulatory requirements). • AF Subject Matter Expert—Kevin Porteck • AF Subject Matter Specialist—Paul Jurena
Installation Natural Resources Manager/POC	• Natural Resources Manager—John Krupovage (provides program oversight to ensure no net loss in capability of AF lands to support the military mission while sustaining the long-term ecological integrity of natural resources and the ecosystem services they provide) • Natural Resources Biologist—Raymond Moody (serves as lead biologist in support of natural resources management on Tinker AFB).
Installation Security Forces	• Enforces fish and wildlife laws and regulations and supports other conservation requirements
Installation Unit Environmental Coordinators (UECs)	• Serve as conduit between natural resources function and their unit • Ensure units comply with natural resources policies, regulations, laws, and other conservation requirements
Installation Wildland Fire Program Manager	• Dually managed by Tinker AFB Fire Chief & Natural Resources Manager
Pest Manager [Integrated Pest Management (IPM) Coordinator]	• Oversees all aspects of the installation Integrated Pest Management Plan to include as related to in-house, contracted, and out-leased natural resources operations
Range Operating Agency	• Not applicable
NEPA/Environmental Impact Analysis Process (EIAP) Manager	• Ensures proposed federal actions are analyzed to determine, document, and disclose impacts to the environment (to include natural resources)
National Oceanic and Atmospheric Administration (NOAA)/ National Marine Fisheries Service (NMFS)	• Not applicable
US Forest Service	• Not applicable
US Fish and Wildlife Service	• Enforces federal fish and wildlife laws • Supports federal fish and wildlife conservation efforts

Office/Organization/Job Title (Listing is not in order of hierarchical responsibility)	**Installation Role/Responsibility Description**
	• Serves as the primary federal party of the Sike's Act-mandated tripartite core group for cooperative INRMP development, review, signature, and implementation to meet Sikes Act goals.
Oklahoma Department of Wildlife Conservation	• Enforces state fish and wildlife laws • Supports fish and wildlife conservation efforts • Serves as the primary state party of the Sike's Act-mandated tripartite core group for cooperative INRMP development, review, signature, and implementation to meet Sikes Act goals.
Base Civil Engineer	• Oversees execution, advocates for, and allocates resources in support of the base natural resources program • Ensures Civil Engineering natural resources function is appropriately staffed with trained natural resources personnel • Provides appropriate training/continuing education to ensure implementation of the INRMP
Civil Engineering Asset Management Natural Resources Function	• Serves as the lead and technical representative for the installation natural resources program to include but not limited to fish and wildlife, green infrastructure, urban forest, floodplains, wetlands, agricultural lands, and natural resources-related activities such as hunting and fishing • Develops and publishes INRMP to ensure compliance with local, state, and federal laws, federal executive orders, and Department of Defense and Air Force regulations • Identifies and programs resource (budget) requirements • Conducts annual INRMP review with collaborating state and federal agencies • Serves as the liaison with external stakeholders on installation natural resources issues that may also require coordination with Public Affairs and/or Judge Advocate • Serves as the primary Civil Engineering representative on the Bird/Wildlife Aircraft Strike Hazard Committee • Manages contracts, inter-agency agreements, and cooperative agreements for implementation of natural resources projects • Coordinates with installation contracting officer to ensure appropriate environmental requirements are included in contracts and communicate to contractors potential natural resources impacts
Environment, Safety, and Occupational Health Council	• Reviews INRMP major revisions • Ensures represented organizations are familiar and compliant with natural resources stewardship goals,

Office/Organization/Job Title (Listing is not in order of hierarchical responsibility)	**Installation Role/Responsibility Description**
	objectives, policies, and other requirements as outlined in the INRMP
Tenant Unit Commanders	• Ensure unit environmental coordinator and unit personnel support and comply with natural resources stewardship goals, objectives, policies, and other requirements as outlined in the INRMP
Staff Judge Advocate	• Review proposed federal natural resources laws and regulations for potential impacts to Tinker AFB and communicate potential impacts • Keep Civil Engineering natural resources function apprised of new natural resources laws and regulatory requirements • Provide legal advice on natural resources issues
Public Affairs Office	• Supports the installation natural resources function as liaison between the installation and external communities • Supports the installation natural resources function though internal media publications and communications
Airmen	• Every Airmen (military, civilian, and contractor), including family members and visitors, is responsible for the stewardship of natural resources on and adjacent to Tinker AFB

5.0 TRAINING

AF installation NRMs/POCs and other natural resources support personnel require specific education, training and work experience to adequately perform their jobs. Section 107 of the Sikes Act requires that professionally trained personnel perform the tasks necessary to update and carry out certain actions required within this INRMP. Specific training and certification may be necessary to maintain a level of competence in relevant areas as installation needs change, or to fulfill a permitting requirement.

Installation Supplement – Training

Natural resources management training is provided to ensure that base personnel, contractors, and visitors are aware of their role in the program and the importance of their participation to its success. As appropriate, training records are maintained IAW the Recordkeeping and Reporting section of this plan. Below are key NR management-related training requirements and programs:

- Tinker AFB is a Category I installation which requires NRMs to take the course*, DoD Natural Resources Compliance,* endorsed by the DoD Interservice Environmental Education Review Board and offered for all DoD Components by the Naval School, Civil Engineer Corps Officers School (CECOS). The present Tinker NRM completed this course in August 1998.
- Natural resource management personnel at Tinker AFB routinely attend appropriate national, regional, state, and local conferences, seminars, and training courses. Some attended include:
    - Oklahoma's Biodiversity Conference
    - Bird/Wildlife-Aircraft Strike Hazard Workshop

  - Stream and River Corridor Management
  - Wetlands Regulation Conference
  - Watchable Wildlife Conference
  - DOD Legacy Workshop on Riparian Ecology, Restoration, and Management
  - Tree City USA National Conference
  - DOD/Interagency Workshop on Technologies to Address Soil Erosion on DOD Lands
  - Midwest Oak Savannah and Woodland Ecosystem Conference
  - Conference on Conservation and Ecology of Grassland Birds
  - An Approach to Ecosystem Conservation
  - Principles and Techniques of Electrofishing
  - Volunteer Recruitment and Management
  - Building Community Support
  - GIS Introduction for Conservation Professionals
  - The Excellence in Leadership Certificate Program
  - How to Become a Great Communicator/How to Make Presentations with Confidence and Power
  - Effective Facilitation
  - Strategic Conservation Planning Using a Green Infrastructure Approach
  - Air Force Landscape Architecture and Sustainability Training Workshop
  - DOD Pest Management Quality Assurance Evaluator Course
  - Wildland Fire Fighter training (S-190 Introduction to Fire Behavior)
  - Wildland Fire Fighter training (S-130 Introduction to Fire Fighting)
  - Wildland Fire Fighter training (S-131 Firefighter Type 1)
  - National Military Fish and Wildlife annual meetings/training workshops
- Natural Resources staff periodically host in-house training workshops for staff, volunteers, contract monitors, and others to ensure consistent, quality, and safe execution of natural resources activities such as tree care and chainsaw use. Field and classroom instruction is provided by professionals such as the Oklahoma state urban forester and the Oklahoma County Extension Agent.
- Natural Resources staff routinely tour/brief base personnel such as Employee Enhancement Program participants, Supervisor Development Program students, and others to communicate the base conservation mission and vision. It is a routine practice to conduct a field tour for all new Air Base Wing commanders and vice commanders upon their assumption of duties.
- Pest management personnel who capture and handle nuisance wildlife on TAFB must pass an ODWC Nuisance Wildlife Control Operator's course which qualifies them to possess the requisite state Nuisance Wildlife Control Operator's license.
- All individuals who will be enforcing fish, wildlife and natural resources laws on AF lands must receive specialized, professional training on the enforcement of fish, wildlife, and natural resources in compliance with the Sikes Act. This training may be obtained by successfully completing the Land Management Police Training course at the Federal Law Enforcement Training Center (http://www.fletc.gov/).
- USDA Wildlife Services and the Pest Management Shop support the BASH program. Both are flight line driver's-trained. USDA staff are degreed in wildlife biology which includes bird identification. USDA receives initial airport wildlife control training; advanced training in mitigating wildlife hazards at airports; Immobilization and Euthanasia training; and annual component training for firearms. Others, such as Base Operations, who are authorized to haze wildlife are periodically trained in pyrotechnic use.

6.0 RECORDKEEPING AND REPORTING

6.1 Recordkeeping

The installation maintains required records IAW Air Force Manual 33-363, *Management of Records*, and disposes of records IAW the Air Force Records Information Management System (AFRIMS) records disposition schedule (RDS). Numerous types of records must be maintained to support implementation of the natural resources program. Specific records are identified in applicable sections of this plan, in the Natural Resources Playbook and in referenced documents.

Installation Supplement – Recordkeeping

Natural resources records are maintained on the Electronic Records Management System (ERMS), on natural resources staff computers through the base network, and on some hard copy documents.

6.2 Reporting

The installation NRM is responsible for responding to natural resources-related data calls and reporting requirements. The NRM and supporting AFCEC Media Manager and Subject Matter Specialists should refer to the Environmental Reporting Playbook for guidance on execution of data gathering, quality control/quality assurance, and report development.

Installation Supplement –Reporting

Natural resources-related reporting consists of the following:

- Depredation at Airports Migratory Bird Permit Renewal & Permit Questions (annual—Natural Resources Function permit holder to USFWS)
- Depredation Permit Review WS Form 37 (annual—USDA Wildlife Services Biologist to Natural Resources Function)
- Depredation Annual Report Form 3-202-9 (annual—USDA Wildlife Services Biologist to Natural Resources Function)
- Scientific Collectors Permit Application and Collection Report (annual—Natural Resources Function license holder to ODWC)
- Nuisance wildlife trapping report (annual—Pest Management Shop to ODWC)
- Tree City USA recertification (annual—Natural Resources Function to Oklahoma Department of Agriculture, Forestry Services)
- Management Internal Control Toolset (MICT) reporting
- Natural Resources Program Annual Report (annual—Natural Resources Function to Sikes Act tripartite core group, i.e., Air Base Wing Commander, USFWS, and ODWC)

Natural resources data calls typically include:

- Deputy Assistant Secretary of Defense (DASD) Environmental Safety and Occupational Health (ESOH) Semi-Annual Environmental Quality (EQ) Data Call (semi-annual—Natural Resources Function to AFCEC)
- AF Forestry/Agriculture/Fish & Wildlife Reimbursable Natural Resources Program Operating Budget (annual—Natural Resources Function to AFCEC)

7.0 NATURAL RESOURCES PROGRAM MANAGEMENT

This section describes the current status of the installation's natural resources management program and program areas of interest. Current management practices, including common day-to-day management practices and ongoing special initiatives, are described for each applicable program area used to manage existing resources. Program elements in this outline that do not exist on the installation are identified as not applicable and include a justification, as necessary.

Installation Supplement –Natural Resources Program Management

No Installation Supplement

7.1 Fish and Wildlife Management

Applicability Statement

This section applies to all AF installations that maintain an INRMP. The installation is required to implement this element.

Program Overview/Current Management Practices

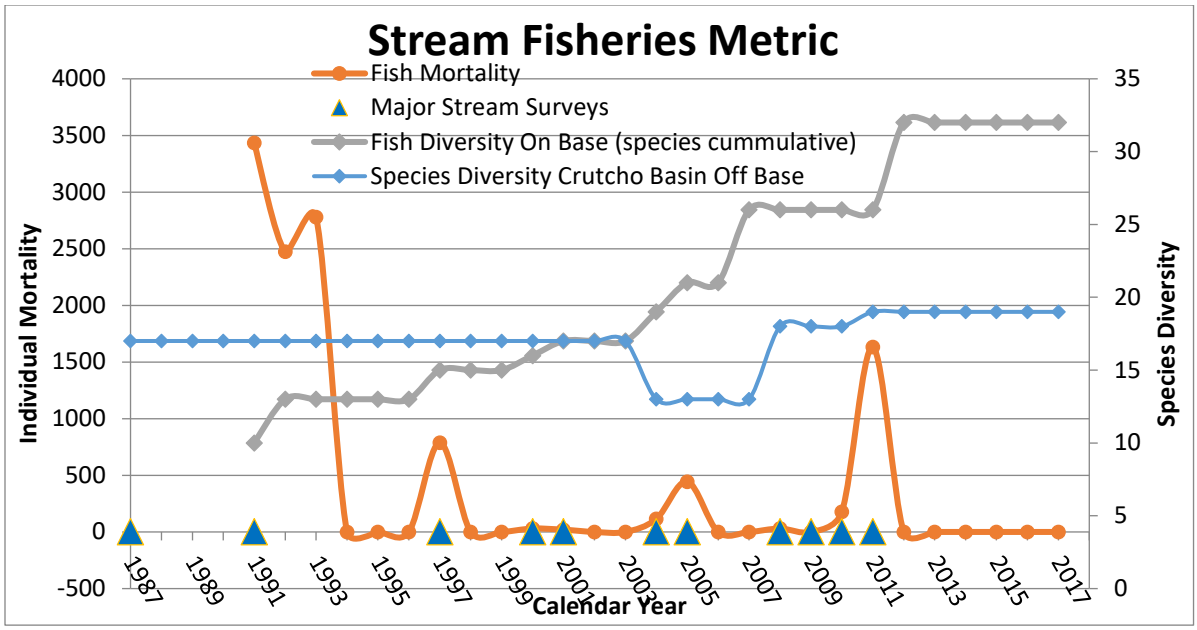
Tinker AFB is classified as a Category 1 installation (i.e., has suitable habitat for conserving and managing fish and wildlife) by AFI 32- 7064. Therefore, management of flora and fauna under specific management plans has been on-going since the first plan was published in the 1980's. Since that time, several iterations of this plan have been accomplished by in-house natural resources staff. In general, the habitat and management strategies have focused on increasing floral and faunal abundance and diversity, with the exception of the airdrome where the opposite strategy is employed. This strategy implements directives to conduct ecosystem management while, where appropriate, decreasing the potential for bird/wildlife aircraft strikes. Surveys have shown this strategy is working—species richness and diversity are indeed higher in green space areas and notably lower on and near the airfield and industrial areas (Bogosian, et al., 2012).

The overarching fish and wildlife management strategic aim is to provide a healthy native ecosystem which does not conflict with, but supports, the military mission. For example, fish and wildlife management provides base residents and employees with recreational fishing and other wildlife-related activities such as nature photography and viewing.

Sections below show current statuses and trends and how specific management activities have helped floral and faunal communities recover and, in some cases, thrive both on Tinker AFB and in surrounding communities.

Fisheries Management

Upon completion of the studies summarized in Section 2.3, Ecosystems and the Biotic Environment, results indicated fish assemblages in the Tinker AFB Crutcho Creek system are stable and similar to many other Mid-western fish assemblages (Marsh-Matthews, et.al. 2010) (see figure, "Fish Mortality vs Diversity").



Fish Mortality vs Diversity: Fish mortality resulting from fish kill events and species diversity from survey records on Tinker AFB (Source: Tinker AFB, Natural Resources Records 1990- 2017).

Fauna (Fish)

Status

Trend

Metric: Overall status of fish is stable with a high percent similarity index (PSI) score of 0.754 established from the latest stream surveys. Scores of over 0.50 are considered to be stable fish assemblages (Marsh-Matthews, et.al., 2010). As confirmed by current and past studies, species richness has increased over the years, with 33 total species identified on Tinker AFB. Fish kill frequency and severity are also down over the last twenty years, further contributing to stability and diversity of Tinker's fish assemblages. The trend is expected to be stable to upwards as water quality and stream habitat are improved.

Sport Fisheries Management

Tinker's sport fisheries provide for primary consumptive uses of fish and wildlife. Currently, Prairie, Primrose, Redbud, Beaver, and Beaver Marsh Filter Ponds (see figure, "Tinker AFB Sport Fisheries") are managed for a self-sustaining largemouth bass (*Micropterus salmoides*) and bluegill (*Lepomis macrochirus*) fishery. Channel catfish (*Ictalurus punctatus*) and rainbow trout (*Oncorhynchus mykiss)* are also supplementally stocked on a put-and-take basis (i.e., not a self-sustaining or reproducing population). Other sport fish found in Tinker's ponds include: red-ear sunfish (*Lepomis microlophus*), hybrid sunfish *(Lepomis macrochirus X microlophus and X cyanellus*), green sunfish (*Lepomis cyanellus*), longear sunfish (*Lepomis megalotis*), warmouth (Lepomis gulosus), and white crappie (Pomoxis annularis).

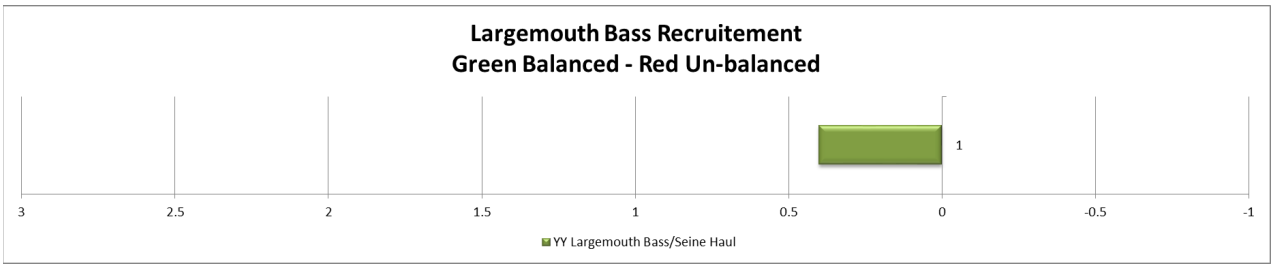
Tinker AFB Sport Fisheries: Recreational fishing ponds and connecting trails on Tinker AFB.

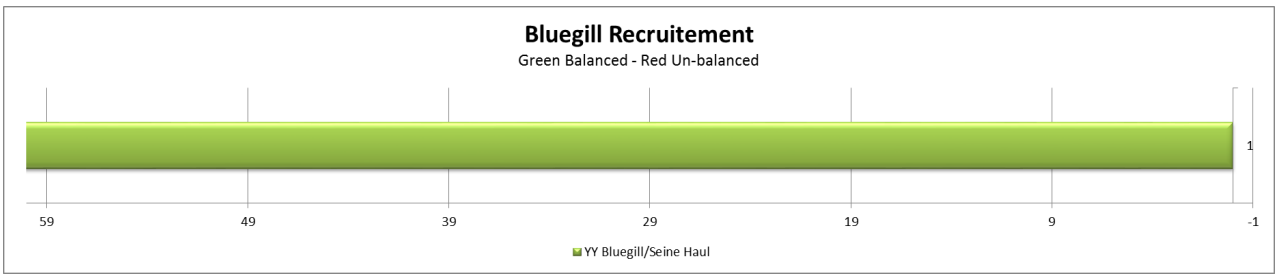
Tinker AFB streams also provide opportunities for sport fishing. Sport species present are Largemouth bass (*Micropterus salmoides*), Spotted bass (*Micropterus puctulatus*), sunfish (*Lepomis sp.*), White crappie (*Pomoxis annularis*) and Channel catfish (*Ictalurus punctatus*). Open waters for stream fishing include Crutcho Creek along Mitchell Ave. near the base housing area and north of Arnold Drive to the first low-water crossing.

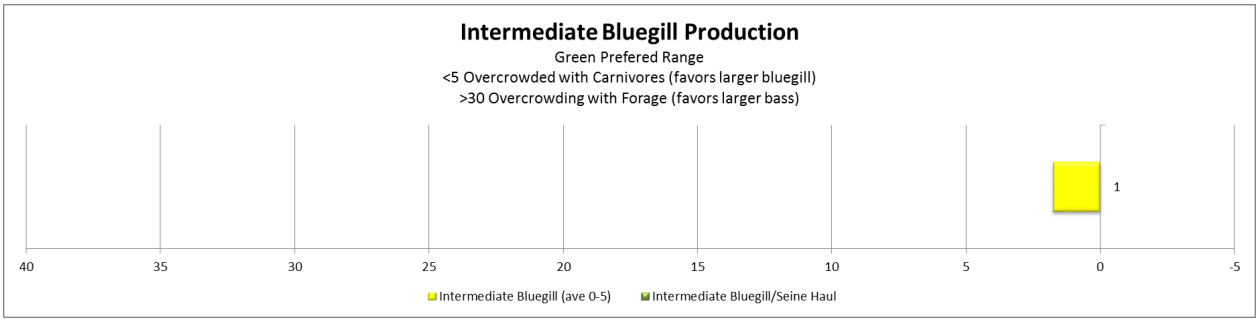
Tinker AFB biologists conduct annual fall seine surveys in Tinker AFB ponds to determine if recruitment of bass and bluegill is occurring and to determine the predator-prey balance of ponds. Field survey methodologies have been adapted from the early published work of H.S. Swingle and L.G. Hill from the University of Oklahoma. Results are presented here for interpretation using bar graph balances developed by Moody (Swingle 1956, Hill 1989, and Moody 2010). These results are used to develop stocking rates and

habitat improvement for base ponds. Examples, of these indicators for 2016 are shown below for Prairie Pond and Beaver Marsh Filter Pond (see figure, "2016 Fall Seine Results for Prairie Pond").

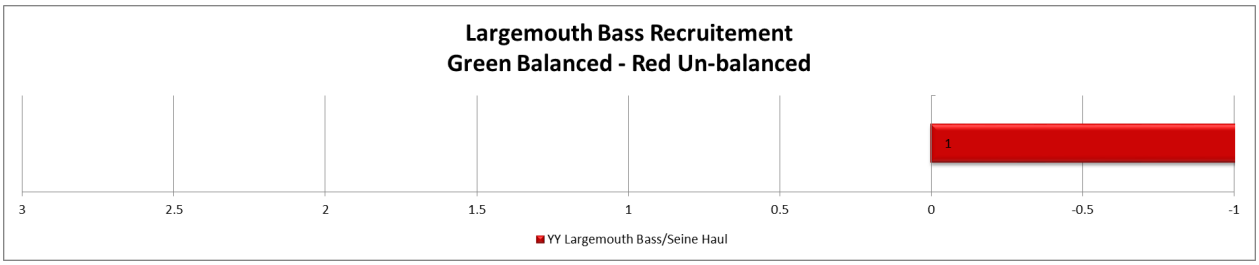
These indicators allow Tinker AFB biologist to make sound management recommendations. For example, a minor recommendation could be implemented, such as increasing cover for intermediate bluegill.

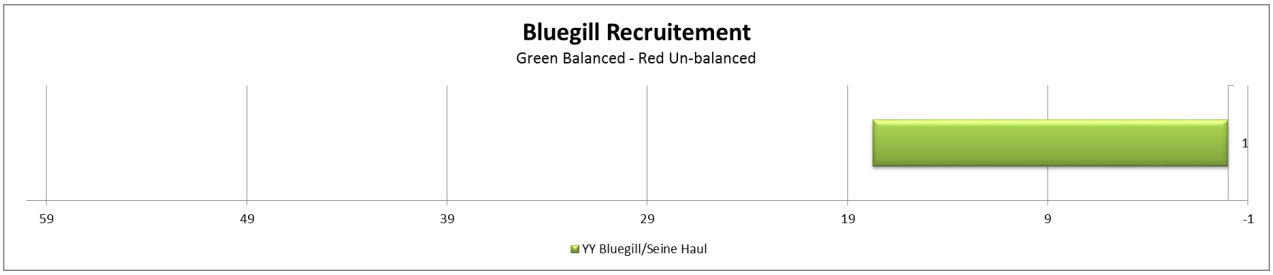


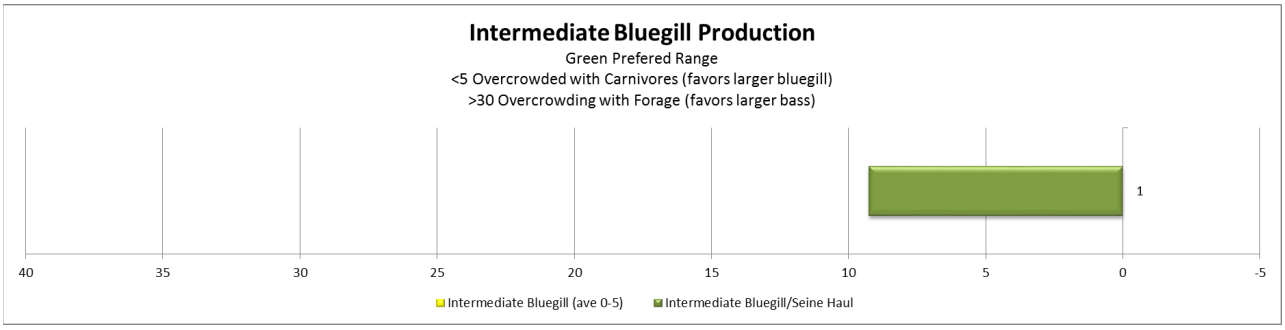




2016 Fall Seine Results for Prairie Pond: These results indicate a balanced predator-prey relationship for bass and bluegill populations. Intermediate forage or sunfish numbers indicate fairly high predation by adult bass or other predatory species and below preferred ranges - yellow bar).







2016 Fall Seine Results for Beaver Marsh Filter: These results indicate an unbalanced predator-prey relationship since bass did not reproduce (i.e., red bar); however, adult bass were present and bluegill had good reproduction. Intermediate bluegill numbers were also up and indicate predation by adult bass to be moderate but still in preferred ranges. Largemouth bass fingerlings have been stocked to supplement reproduction in this pond. Management recommendations from these surveys are implemented in the INRMP Annual Work Plan.

Sporting Fishing Regulations

Fishing regulations have been standardized across all Tinker AFB ponds and streams to simplify them and make them easily understood. Tinker AFB regulations are shown in Section 1, paragraph 1.3 “Authority” and are posted at each pond as shown in the figure, “Base Fishing Regulation Sign." All other regulations coincide with the Oklahoma “Fishing Guide” regulations available on the Oklahoma Department of Wildlife Conservation web site (www.wildlifedepartment.com).

Fishing Permit Sales Structure

Annual Family ……..……$20.00

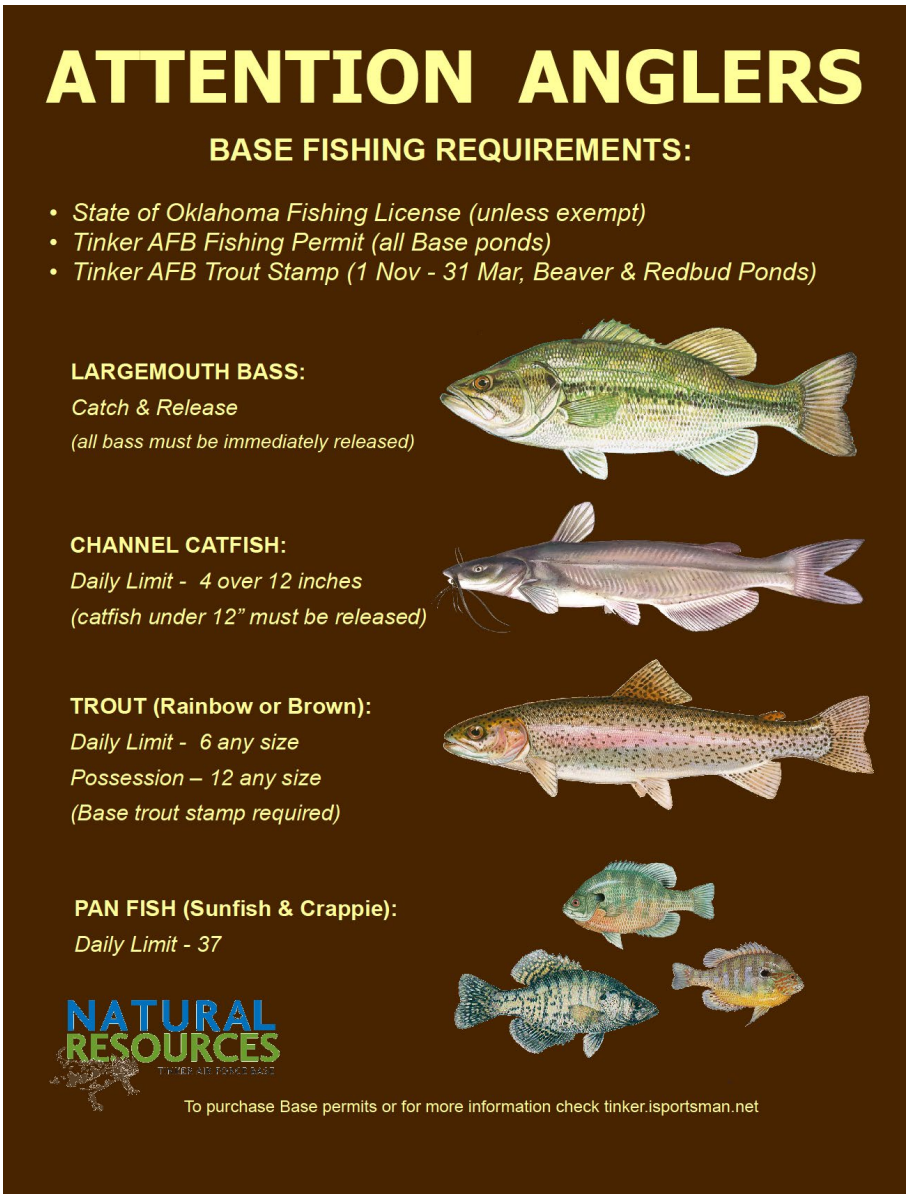
Annual Individual ...…….....$15.00

7-day Individual ……..…….....$10.00

Seasonal Individual Trout Stamp…...$15.00

Seasonal Family Trout Stamp……...$20.00

- *Fishing permits are purchased on-line at tinker.isportsman.net*
- *A valid State of Oklahoma fishing license is also required to fish in base ponds and streams.*



Base Fishing Regulation Sign: Signs are posted at each Tinker AFB fishing pond.

Only "Catch and Release" fishing is allowed for largemouth bass in Tinker AFB ponds and streams due to fishing pressure and to maximize trophy bass potential. Along with this management technique, ponds will continue to be supplementally stocked with bass. Limits for channel catfish have been set at four fish over 12 inches in all Tinker AFB ponds and streams. Beaver Pond has been designated as a "Kids" fishing pond, targeting large, easily harvested pan fish. To further this objective hybrid sunfish (*Lepomis cyanellus x machrochirus*) are being stocked regularly to provide a large easily catchable fish for kids. Limits for sunfish and other pan fish have been set at 37 (the current state limit) to encourage harvest and stimulate production. Crappie typically require larger (> 10 acres) bodies of water to produce sustainable populations. Crappie limits also have been set at 37 to reduce crappie over-crowding which could result in an imbalanced fishery.

A winter trout fishing program was started in 2004 with the first stocking of brook (only in initial year of stocking), rainbow, and brown trout in Redbud and Beaver Ponds. Its success has resulted in an ongoing

trout stocking program which typically starts on Veteran's Day and ends in by April or May when water temperatures rise to lethal levels for trout. Anglers are required to purchase a Tinker AFB fishing permit and a trout stamp to fish for trout. The base fishing program is managed by the natural resources function in the Civil Engineering Directorate. A permit/license system is administered through "iSportsman," an online licensing system approved by USAF. To purchase permits, anglers go on-line to "tinker.isportsman.net" and set up an account to purchase appropriate permits. Anglers needing assistance purchasing permits on-line can visit the natural resources office (Building 811) and be assisted in person. This site also has up-to-date fishing information for the base. All anglers 16 years of age and over must possess an Oklahoma State fishing license and a Tinker AFB fishing permit (unless otherwise exempt – see Oklahoma Fishing Guide). Permit prices have been established, and the structure is as follows: Annual Family ($20.00), Annual Individual ($15.00), 7-day Individual ($10.00), Seasonal Individual Trout Stamp ($15.00) and Seasonal Family Trout Stamp ($20.00). A free, natural resources staff-issued fishing permit is also available for special use and aquatic educational events such as fishing derbies and other approved events. Fishing receipts are earmarked for the Tinker AFB fishing program with trout stamp receipts going exclusively to trout stocking. There are no "user restrictions" or protocols other than those posted on "tinker.isportsman.net" and established under the Tinker AFB fishing proclamation, Oklahoma "Fishing Guide," and trail user rules posted on trailhead signage. Users of Tinker's recreational resources are comprised of Department of Defense prime contractor employees and active and retired Department of Defense military and civilian employees, their dependents, and guests (see Section 7.2 for more detailed breakdown of permitted users). Open public use of these resources is not possible because of limitations imposed by mission security requirements. Also, the limited size of recreational areas coupled with an increasing Tinker AFB population makes public use unfeasible. However, on a controlled basis, escorted individual guests, scouting groups, sporting clubs, and similar groups can be granted access and purchase permits to fish on Tinker AFB outdoor recreation areas.

Fishing Permit Sales: Tinker AFB fishing permit sales recorded from 1999-2019.

Tinker's natural resources function actively pursues goals of federal Executive Order 12962, Recreational Fisheries (2008). This aims to improve quantity, function, sustainability, and productivity of aquatic resources which result in an increase of recreational fishing opportunities. Some of the objectives being accomplished include: cooperative stocking efforts of channel catfish with ODWC (over 1,000 stocked annually), restoration of aquatic/fish habitat (in-house efforts), managing for sustainable fish stocks (bass-bluegill fisheries), hosting awareness and outreach events (fishing derbies/clinics), cooperative research of fish assemblages in Tinker AFB streams (University of Oklahoma Cooperative Agreement), and winter trout fishing (stocking of over 1,000 trout annually). Natural resources staff have also noted trends of increasing fishing permit sales when angler creel and permit checks were conducted. Therefore, Natural resources staff will continue these checks and monitor results of efforts to maximize permit sales. We have also worked through programs of the National Recreational Fisheries Coordination Council and Sport Fishing and Boating Partnership Council to secure fishing rods and reels for our youth fishing clinics and derbies. These derbies are held in cooperation with the Oklahoma Aquatic Resources Education Program of ODWC. These efforts are reflected in the upward trend of permit sales (see figure, "Fishing Permit Sales").

Fauna (Sport Fisheries)

Status

Trend

Metric: Tinker AFB fishing permit sales have shown a steady increase over the last decade with a few year-to-year fluctuations. Sales increased significantly in 2017-19 and are expected to continue to increase with continued permit surveillance and implementation of online permit sales (see figure, "Fishing Permit Sales".

Mammal Management

Mammal management on Tinker AFB is primarily related to wildlife aircraft strike hazards and focuses on sensitive areas such as on and surrounding the airfield (see section 7.12 and deer management section below). Some nuisance animal control is also implemented around facilities and housing areas and is accomplished by base contract in accordance with the Tinker Integrated Pest Management Plan (see sections 7.11, 15, and Tab 5). The metric for overall mammal management is linked to species diversity which is summarized in the Species Survey Table found in Section 7.1.

Fauna (Mammals)

Status

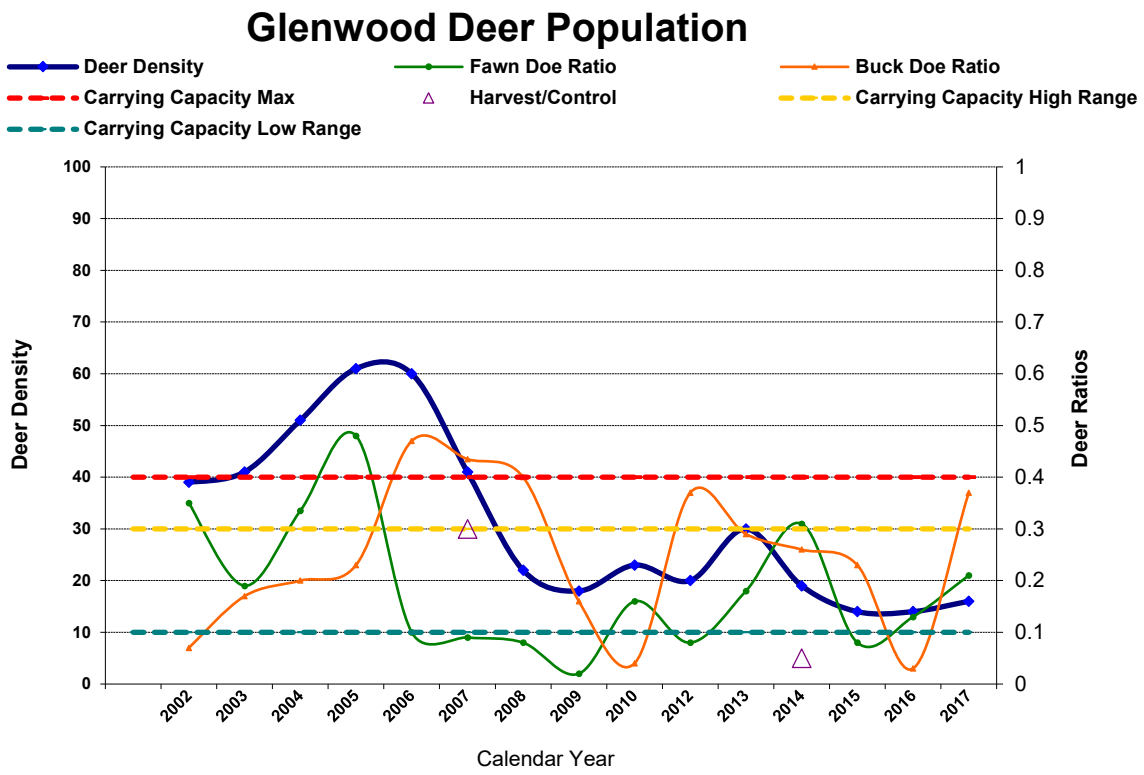
Trend

Metric: Mammal status is stable with a higher diversity (0.33 – 5.05) in green space areas than more urbanized areas. The trend is upward and is expected to continue this trajectory due to ongoing grassland, woodland, and aquatic system restoration.

Mammal Management (Deer)

White-tailed deer populations are increasing on and around Tinker AFB. On-base sightings, as well as sign (i.e., tracks and scat), have occurred at the Urban Greenway, munitions area (southeast corner of base off airfield), TAC, and Glenwood. Deer activity on the airfield is very infrequent with two individuals having been removed by USDA Wildlife Services personnel between 1989 and 2019. Numerous deer occurrences in Glenwood (see figure, "Glenwood Deer"), a satellite training area north of Tinker AFB, were first noted in the mid-1990's. This is a high-fenced area with approximately 280 acres in the airfield's clear and accident potential zones. Additionally, deer are known to frequent other satellite areas and are numerous around the Lake Stanley Draper area south of Tinker AFB. Spotlight deer surveys have been conducted annually in the Glenwood since 2002. Survey methodology follows guidelines found in the Samuel Roberts Noble Foundation, *Spotlight and Daylight Survey of Deer: Collecting and Interpreting Data* (Stevens R., 2001). Glenwood estimated deer densities are shown in figure, "Glenwood Deer Population Trends."

Glenwood Deer: A deer photographed by a wildlife motion sensor camera in the Glenwood area.



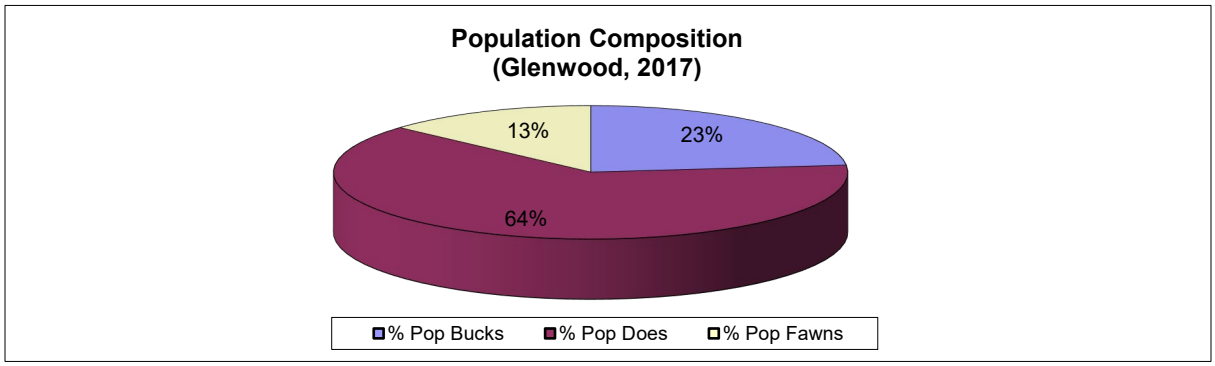
Glenwood Deer Population Trends: Density, ratios, and carrying capacity estimate for Glenwood deer population. The triangles along the x-axis represent controlled harvest of deer.

In 2007, following record deer numbers, control measures were taken in the Glenwood area after declining deer health and browse lines were observed. Thirty deer (26 females and 4 males) were harvested in conjunction with USDA Wildlife Services and under depredation permits issued by the Oklahoma Department of Wildlife Conservation (ODWC). Biologists from TAFB, USDA Wildlife Services, and ODWC conducted a health assessment on the first 10 deer harvested at Glenwood. Findings validated an overpopulated herd. Harvested carcass weights were well below typical deer weights for this region which ranged from 61 to 121 pounds (average 87.5) (Caire W. et. al., 1989). Several deer were emaciated. All deer collected had no fat reserves present, and biologists believed that muscle mass was being lost due to starvation. Considering deer condition, ODWC recommended harvesting 20 additional deer to bring population levels to the estimated carrying capacity of 40 deer for the area (see figure, "Glenwood Deer Population Trends"). In addition, they recommended providing supplemental feed (i.e., corn) for the remainder of the herd until the spring green-up when forage became available. Without these measures, ODWC believed a mass die-off could have occurred the following summer. Natural resources staff biologists concurred with this assessment and continued with an additional harvest of 20 deer and supplemental feeding until that spring. Samples were taken for Chronic Wasting Disease (CWD) and were negative. Final assessments determined declining deer health was the result of malnutrition due to overcrowding. Carcasses harvested were donated to the Little River Zoo and Hunter's Against Hunger, a non-profit program providing food for the underprivileged. Additional data collected from the annual surveys supported health assessment findings and suspected herd conditions. Fawn to doe ratios during this time were consistently under 0.50 which is the threshold for a deer population being at or over carrying

capacity (Miller and Marchinton, 1995). Glenwood deer herd population trend and composition are found in figures "Glenwood Deer Population Trends" and "Population Composition-Glenwood, 2016."

In Glenwood, deer densities may likely be supported over theoretical carrying capacities with deer aggregations occurring (Halls, 1984). Sufficient habitat migration linkages and ample forage and water are present within this unique urban setting. Deer densities have occurred over their theoretical carrying capacity in the past (2003-2007). Estimated Glenwood carrying capacity is at a maximum elevated level at 40 deer (see figure, "Glenwood Deer Population Trends"). This is primarily determined from observations of declining habitat conditions and corresponding elevated deer densities as well as health assessments over survey years. Biologists have concluded that the preferable carrying capacity for the herd is 30 deer and has targeted this level for maintenance of the population. This indicator is a useful tool in meeting deer herd management goals including improving deer health and minimizing negative deer-related issues. Spotlight survey data collected after the managed deer harvest in 2007 followed with an expected decreasing trend. Population density was immediately lowered below carrying capacity in 2008 and 2009. Additionally, field observations during these time periods concluded that browse lines had disappeared, and vegetation condition in Glenwood had recovered. In 2010, deer density levels began to increase as expected but remained steady at around 20 deer through 2012. However, for the 2013 survey herd levels showed an increase to 30 deer, a point at which harvest was determined to be necessary to maintain sound population levels. In March 2014, five does were harvested through depredation permits issued by ODWC. These deer were in generally good health with field-dressed weights ranging from 80-90 pounds. All five of the deer were donated to ODWC's Hunter's Against Hunger Program. The fall 2014-2017 deer surveys indicated population numbers back down to desirable ranges of 15-19 deer. While currently below carrying capacity, it is expected that intermittent control measures will be needed periodically.

In keeping with Executive Order 13443, *Facilitation of Hunting Heritage and Wildlife Conservation* (2007), strategies to develop hunting opportunities in the Glenwood area have been explored to help control deer populations. Many factors were considered such as Glenwood being a military training area, aircraft accident potential and clear zones, proximity of area to off base residential areas, and manpower required to manage a hunting program. These conditions and the low number of deer which could be harvested annually make it infeasible for a hunting program at this time. However, these issues will be monitored and reevaluated periodically to determine if a hunting program should be implemented. Other hunting programs, such as falconry, will be considered on a case-by-case basis by natural resources staff.



Glenwood Deer Population Composition

Fauna (Deer)

Status

Trend

Metric: The status of the Glenwood deer herd is good and well within the area's carrying capacity range of 10-30 deer. The trend is upward as the population has rebounded since five deer were harvested in 2014. (Deer density =16; Fawn:Doe ratio=0.21; Buck:Doe ratio=0.37). Fawn doe ratios are still well below 0.50 and slightly increasing indicating a stable but the potential for herd population growth.

Reptile and Amphibian Management

Reptile and amphibian species occurrences and are geo-referenced and recorded in Tinker's Arc Geographic Information System (GIS) animal database. In the Bogosian (2011) study herpetofauna were found to have higher diversity in green space areas (see table, "Species Survey" in Section 7.1). These results are likely due to natural area management and lack of suitable habitat in industrial and airfield environments. This study also commented that results were comparable to similar surveys conducted on other southwestern U.S. urban and semi-urban military installations (Bogosian, Hellgren and Moody, 2011). Also of note from this study was that approximately half of the species known to occur in Oklahoma County and adjacent counties were detected. Urban development often changes the composition of native plant and animal communities as well as ecosystem functioning. However, as compared to surrounding municipal development, military installations often serve as refugia for floral and faunal communities as attested by the above studies.

Several reptile and amphibian species are being used as indicators of ecosystem health and more detailed information are provided on those species under "Indicator Species." The Texas horned lizard is also addressed in Section 7.4 under "Texas Horned Lizard Management" where much detailed research and information can be found.

Fauna (Reptiles and Amphibians)

Status

Trend

Metric: The status of reptiles and amphibians is stable with high diversity (0.33 – 5.05) in greenspace areas. The current upward trend is expected to continue with ongoing grassland, woodland, and aquatic system restoration.

Bird Management

The majority of bird species found in Oklahoma and at Tinker AFB are considered migratory and are protected under the Migratory Bird Treaty Act (MBTA) of 1918 (50 CFR Part 21) and other important treaties and acts:

> *"The MBTA provides that it is unlawful to pursue, hunt, take, capture, kill, possess, sell, purchase, barter, import, export, or transport any migratory bird, or any part, nest, or egg or any such bird, unless authorized under a permit issued by the Secretary of the Interior. Some regulatory exceptions apply. Take is defined in regulations as: "pursue, hunt, shoot, wound, kill, trap, capture, or collect, or attempt to pursue, hunt, shoot, wound, kill, trap, capture, or collect." The MBTA protects over 800 species of birds that occur in the U.S. (USFWS, Migratory Birds Page, 2011)"*

These laws protect our important avian fauna and provide mechanisms, such as permits (50 CFR Part 13), to ensure balanced use and conservation of this important natural resource. Since 2001, Tinker AFB has partnered and worked under cooperative agreement and permits with USDA Wildlife Service in conducting an integrated bird/wildlife damage management program. Tinker AFB (72 ABW/CEIEC) holds the bird depredation permit.

Tinker also complies with Federal Executive Order 13186, *Responsibilities of Federal Agencies to Protect Migratory Birds.* In partial fulfilment of the MBTA and this order, Tinker observes 1 Apr through 31 Jul as migratory bird breeding season. Special bird protection requirements and permitting are required by on-base personnel and contractors when working on sites with nesting migratory birds.

Tinker contracted with Virginia Tech to conduct a survey that was used in two ways in the management of avian species on Tinker AFB. The first was as a determination of bird richness and indication of species present and migratory trends. Secondly, it was used to help determine birds that were potential threats to aircraft operations and how to better manage Bird Air Strike Hazards (BASH).

One objective of the Virginia Tech (St. Germain, 2010) survey was to develop metrics to monitor avian populations within the airfield and green space areas. To accomplish these tasks, the study site was divided into 5 areas and 44 circular variable radius plots were established (see figure, Virginia Tech Bird Study Map). These plots were monitored seasonally in 2008-2009 for avian diversity and abundance. Aircraft bird strikes were also analyzed from both USAF and Tinker's BASH data sets to determine relative strike probabilities by species and are discussed in detail in the Bird/Wildlife Aircraft Strike Hazard (BASH) section.

Results of the study (St. Germain, 2010) showed spring had the highest diversity base-wide with 107 (species richness) followed by summer (68) and fall (56). The top six most abundant birds were eastern meadowlark 0.30 (relative abundance - ra), Franklin gull 0.179 (ra), European starling 0.108 (ra), mourning dove 0.042 (ra), northern cardinal 0.042 (ra) and barn swallow 0.041 (ra).

Simpson's Diversity Index and species evenness (Krebs 1999) were calculated for each survey area by season, diversity ranges from 0 (low diversity) to near 1 (high diversity). This diversity index will be used as a metric for Tinker AFB avian species and establishes a baseline for future comparison. Species diversity of all areas and seasons was high and ranged from 0.815 to 0.954. The overall species diversity and richness is fairly consistent between various regions on the installation with the exception of the airfield, which is much lower. Greatest species richness was during spring, followed by summer, then fall and winter. This observation would be expected given the geographic location of the installation in the central flyway. For each season the greenway region consistently contained the most species, followed by the golf course and urban areas. The golf course and urban areas are rich in water features with buffer zones consisting of native vegetation. The Glenwood and EIG region had similar richness during spring and summer, but was lower than golf course and urban areas during fall and winter. Of non-airfield regions, the Tinker Aerospace Complex (TAC) had the lowest species richness. This area is in a primarily urban setting with approximately 100 acres of essentially treeless mixed native/non-native grassland, two water detention basins with little

buffering vegetation present. However, this area did have the largest number of dickcissels on the installation.

Virginia Tech Bird Study: Forty-four circular radius plot/point counts with vegetative communities map as background.

Fauna (Birds)

Status ■

Trend ⬌

Metric: Based on Virginia Tech's bird inventory of TAFB, the Simpson Diversity Index indicates the status of birds is stable with high diversity (0.815 – 0.954). Diversity ranges from 0 (low diversity) to near 1 (high diversity). The trend is expected to move upwards as habitat improvements such as grassland and woodland habitat restoration continues. This initial inventory and index values establishes a baseline and a comparison for future years.

Invertebrate Management

Invertebrate management has been related mostly to habitat improvements. Removing invasive plants and increasing the diversity of native trees, shrubs, grasses, forbs, and other plants have been the primary focus to increase invertebrate richness and diversity. About 200 acres on base are being restored to healthy native prairie, woodland, and aquatic systems. Prescribed fire is being introduced to new areas to further enhance native system vigor and structure. Dozens of plants which once occupied the prairie on Tinker have been reintroduced through seeding and plugging. Natural Resources Staff will also be reviewing the Pollinator Partnership Action Plan (PPAP) provided by the Pollinator Health Task Force to determine ways to further pollinator conservation efforts.

Fauna (Invertebrates)

Status Unknown

Trend Unknown

Metric: Status and trend for invertebrates are unknown. Until more extensive surveys are conducted and existing work progresses, this information will be deficient. The current direction is to continue invertebrate inventories, with a focus on at-risk species, and to restore a diversity of natural habitats.

Indicator Species--Tracking Ecosystem Health

SIU (Bogosian, et al., 2011) conducted a survey titled, *Reptile, Amphibian, and Mammal Assemblages on an Urban Military Base in Oklahoma.* It assessed use of indicator species for ecosystem health on Tinker AFB. Indicator species were defined as species with known life histories whose presence indicate stable or biologically diverse grassland or forest habitat, or species of concern as listed by the Oklahoma Wildlife Action Plan (ODWC, 2005) specifically for Crosstimber and/or Mixed-grass Prairie Ecoregions.

The following reptilian indicator species were chosen: ornate box turtle (*Terrapene ornata*), spiny softshell turtle (*Apalone spinifera*), Eastern river cooter (*Pseudemys concinna*), slender glass lizard (*Ophisaurus*

attenuatus), prairie king snake (*Lampropeltis calligaster*), speckled king snake (*L.getula holbrooki*), and Texas horned lizard (*Phrynosoma cornutum*). Texas horned lizards, spiny softshell turtles, and eastern river cooters were chosen due to being listed as species of greatest conservation need in Crosstimbers and Mixed-grass Prairie Ecoregions according to Oklahoma Wildlife Action Plan (ODWC, 2005). The ornate box turtle and slender glass lizard were chosen due to their representation of stable grassland ecosystems. Prairie and speckled kingsnakes were selected as dietary specialists, and as representatives of stable reptilian populations.

The following amphibian indicator species were chosen: cricket frog (*Acris crepitans*), Great Plains narrowmouth toad (*Gastrophryne olivacea*), and Strecker's chorus frog (*Pseudacris streckeri*). These three frog species were selected because they are least tolerant of habitat disruption (M. R. Whiles, SIU Carbondale, personal communication).

Mammal indicator species chosen included the prairie vole (*Microtus ochrogaster*), fulvous harvest mouse (*Reithrodontomys fulvescens*), coyote (*Canis latrans*), and bobcat (*Lynx rufus*). The vole and harvest mouse were selected as characteristic species of grasslands (Leis et al. 2008). The coyote and bobcat were chosen because they are the system's top predators and require fairly large areas of contiguous habitat.

Study findings brought up questions on the use of some species as system health indicators. For example, the spiny softshell turtle (*Apalone spinifera*) is a species of conservation need in the Crosstimbers and Mixed-grass Prairie Ecoregions in Oklahoma (ODWC, 2006). However, this species was documented at four Tinker AFB areas, including the golf course and wastewater treatment plant. In consulting the ODWC, the spiny softshell was listed in need of conservation, not due to its current low population levels, but due to it being favored by commercial turtle harvesters, concerns of overharvesting in public waters, and because it doesn't disperse well into ponds. Additionally, studies of survival (Plummer et al. 2008) and occupancy (Conner et al. 2005, Rizkalla and Swihart 2006) of spiny softshell turtles in urban and intensively farmed areas found that populations can persist in altered landscapes. These results suggest that these species may not be a good ecosystem health indicator because of their resilience to extensive or periodic habitat disturbances, even in urban landscapes (Plummer et al. 2008).

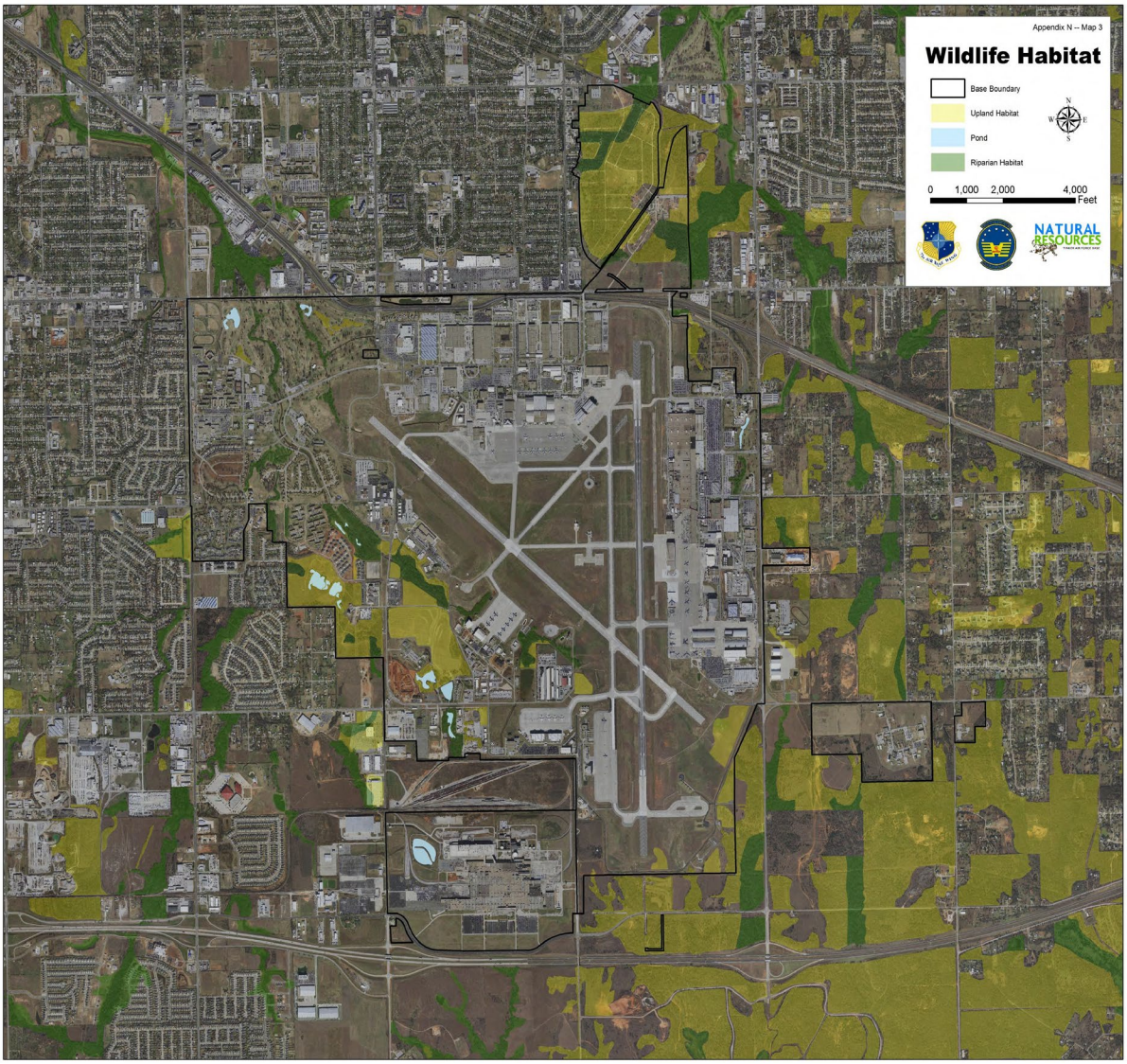
Alternatively, the ornate box turtle (*Terrapene ornata*), readily found on Tinker AFB, would serve as a suitable indicator species. Recent ornate box turtle studies indicate population demographics and genetic diversity are sensitive to habitat fragmentation (Bowen et al. 2004, Kuo and Jackson 2004, Converse et al. 2005). Other studies that have examined turtle population dynamics in disrupted or fragmented habitats have suggested opposite demographic responses of male and female turtles (Dodd and Dreslik 2008, Bennett et al. 2009). These responses are perhaps due to differential strategies employed in balancing trade-off between investment in reproductive resources and growth. In general, turtles may serve as suitable terrestrial indicators of biotic integrity due to importance of adult survival on population persistence (Congdon et al. 1993, Eskew et al. 2010).

Diversity was higher for all species and for indicator species alone in managed greenspace areas when compared to unmanaged, industrialized areas (see Table Species Survey). In addition, using the ad hoc method of adjustment, species diversity scaled by effort was also higher on greenspace areas.
Tinker AFB Urban Greenway Reserves 1 and 3 coupled with the Recycling Center area exhibit spatial connectivity (see figure, "Habitat Favorable to Wildlife Movement and Habitation") and represent focal points for wildlife diversity (see table, "Species Survey").

Species Survey: Shannon-Wiener diversity function for species captured by survey areas, Tinker AFB, 2007-2008 (Southwestern Naturalist, 2011, in-print).

Survey Area	Shannon-Wiener Diversity Index			
	Normal		By 1000 units of effort	
	All species	Indicator species^	All species	Indicator species^
Green Space Areas				
Crutcho Creek Riparian Zone	2.51	0.57	0.87	0.20
EIG/LTA Area	2.32	0.65	0.81	0.23
Fire Pond Area	0.94	0.25	5.05	1.33
Glenwood	2.36	0.63	0.84	0.23
Golf Course Area	2.28	0.51	0.65	0.15
Recycling Center Area	2.70	1.03	0.83	0.32
Urban Greenway (Reserve 1)	2.71	0.53	0.66	0.13
Urban Greenway (Reserve 2)	1.62	0.39	0.33	0.08
Urban Greenway (Reserve 3)	2.89	1.13	0.35	0.14
Unmanaged/Industrialized Areas				
Airfield	n/a	n/a	n/a	n/a
DRMO	1.91	0.67	2.11	0.74
Housing Area	1.61	0.15	1.20	0.11
Industrialized Areas	1.88	0.35	n/a	n/a
Landfill Area	1.10	0.00	0.98	0.00
Munitions Area	1.04	0.00	n/a	n/a
Wastewater Treatment Plant	1.88	0.62	3.93	1.29

Habitat Favorable to Wildlife Movement and Habitation: Areas not regularly mowed on and adjacent to Tinker AFB which is favorable for wildlife movement and habitation.



Fish and Wildlife Management Actions in Response to Climate Change

Fish and wildlife management on TAFB is not likely to change greatly with regard to climate change projections. Current fish and wildlife management issues are likely to persist in the future, such as the presence of invasive/pest species and bird/wildlife aircraft strike hazard (BASH) management. Rising temperatures and increased precipitation are not likely to deter invasive and pest species such as zebra mussels *(Dreissena polymorpha*), grass carp (*Ctenopharyngodon idella*), Asian basket clams (*Corbicula* spp.), domestic dogs, domestic cats, European starlings (*Sturnus vulgaris*), house sparrows (*Passer domesticus*), and rock doves (*Columba livia*). Rising temperatures would likely increase the northward expansion of fire ant populations in Oklahoma to include on Tinker AFB. This could be detrimental to the Texas horned lizard (*Phrynosoma cornutum*), as state-protected species.

Fish and wildlife surveys should be conducted on a regular basis to monitor native species and determine potential impacts. Monitoring of invasives will continue to be important, and management plans should be flexible enough to adapt to changing fish and wildlife concerns (Hellmann et al., 2008). Fire ant monitoring should be routinely accomplished particularly in Texas horned lizard habitat.

Increasing water temperatures will increase the chance of algal blooms occurring, further depleting dissolved oxygen content and habitat suitability (Paerl et al., 2011). Efforts to remove invasive aquatic plants and algae from ponds should be considered, and shade trees should be planted around water sources to prevent excessive heating of water (Poff, Brinson, & Day, 2002).

Climate projections suggest conditions at TAFB that will likely favor vectors for diseases such as mosquitoes and ticks (Süss, Klaus, Gerstengarbe, & Werner, 2008). Minimization of stagnant water in and around cantonment areas will help to reduce mosquito related infections. Tick populations in urban settings can be restricted by keeping lawns mowed and by preventing overabundances of hosts such as deer and rodents. Although annual precipitation is projected to increase slightly, this could be offset by increasing temperatures and drier summers. Open water sources should be allowed to occur at locations that do not present BASH concerns, as wildlife species will likely be drawn to them in times of drought.

Fauna (Indicator Species)*

Status ■

Trend ↑

Metric: Indicator species status is good with a diversity ranging from 0 to 1.33 basewide, with greenspace areas having a higher diversity than more urbanized areas. The trend is upward and should continue this trajectory due to ongoing grassland, woodland, and aquatic system restoration.

** Indicator species include ornate box turtle, spiny softshell turtle, eastern river cooter, Texas horned lizard, slender glass lizard, prairie kingsnake, speckled kingsnake, cricket frog, Great Plains narrowmouth toad, Strecker's chorus frog, prairie vole, fulvous harvest mouse, coyote, and bobcat.*

7.2 Outdoor Recreation and Public Access to Natural Resources

Applicability Statement

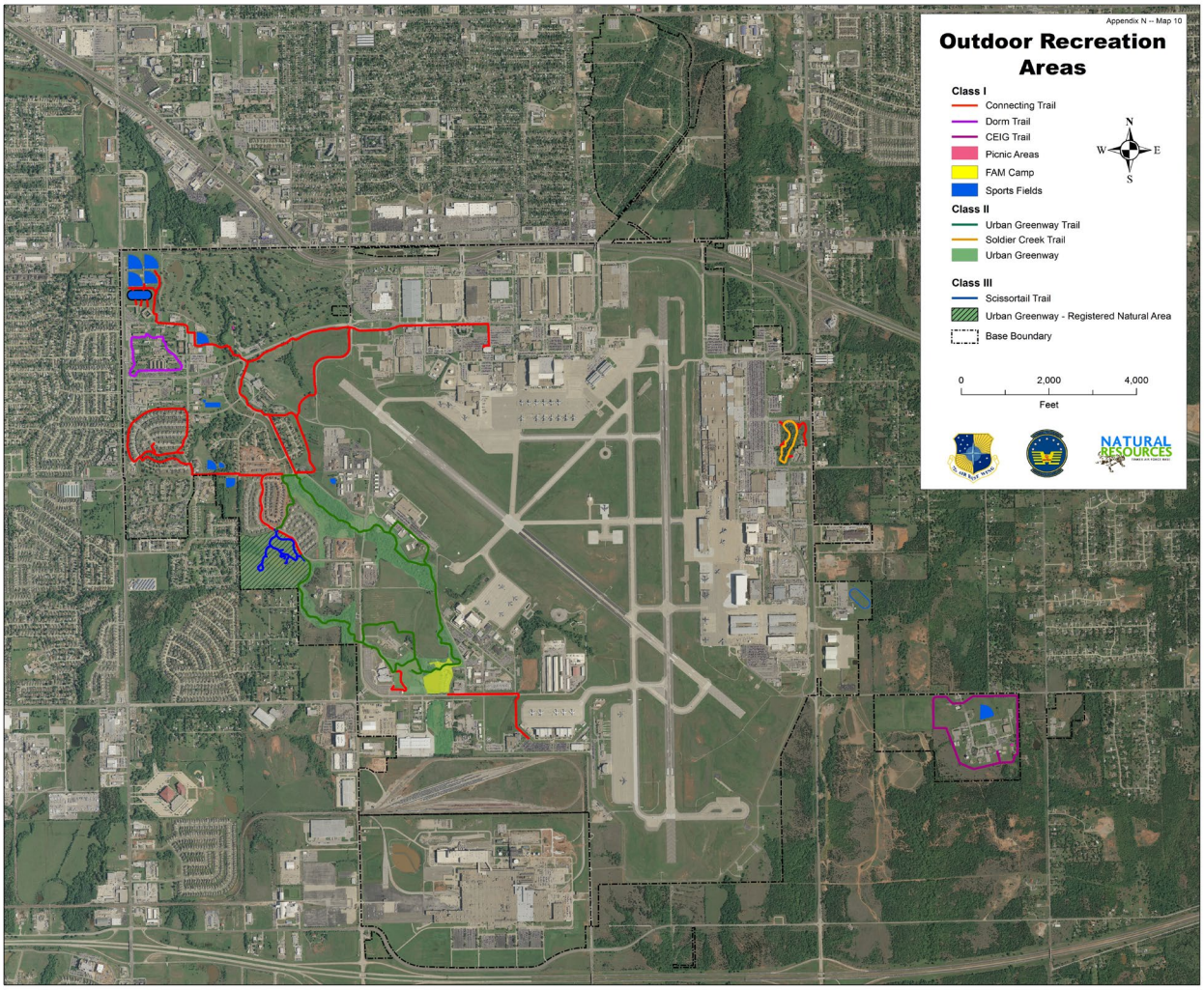
This section applies to all AF installations that maintain an INRMP. Tinker AFB **IS** required to implement this element.

Program Overview/Current Management Practices

Tinker AFB outdoor recreation areas are classified into three categories based on outdoor recreation potential and ecosystem sustainability (see figure, "Outdoor Recreation Areas"):

Class I areas: *developed recreation areas* which contain facilities designed to accommodate intensive recreational activities such as sports fields, campgrounds, picnic areas, paved walking/jogging/cycling trails, winter sports areas, marinas, developed swimming beaches, and other water sports areas.

Existing Tinker AFB Class I areas include: paved multi-use trails (Dorm, CEIG, Connecting Trails), running track, sports fields (soccer, football, and softball), and FAM Camp which provides for full hook-up recreational vehicles (RV), tent camping, and numerous picnic tables. Connecting trails refer to trails connecting facilities such as Gerrity Gym and Navy campus to the Greenway Trail. All Class I areas, except multi-use trails, are managed by the Force Support Squadron (FSS). Multi-use trails are managed by Civil Engineering. Class I rules of conduct may be obtained from FSS Outdoor Recreation personnel and Tinker AFB Fitness Coordinator.



Outdoor Recreation Areas: Existing and potential Class I, II, and III outdoor recreation areas on Tinker AFB

Class II areas: *dispersed recreation areas* which support less concentrated recreational activities such as hunting, fishing, primitive camping, bird watching, boating, hiking, and sightseeing.

Existing Tinker AFB Class II areas primarily consist of the Urban Greenway which includes natural reserve areas with multi-use trails and five fishing ponds. A discussion of the connection and compatibility of Class II recreation areas to the military mission can be found in the Green Infrastructure Plan (Tab 1). All Class II areas are managed by Civil Engineering Directorate (natural resources function) with assistance from Outdoor Recreation, Health and Wellness Center, and others. Rules of conduct for these areas are shown on trailside informational signage and include the following information:

- Stay on trails
- No motorized vehicles on trails (except as necessary for Greenway maintenance)
- No removal of plant materials
- Remove all trash
- Pets must be leashed
- Pet owners must clean up and properly dispose of pet waste

Angling rules of conduct are located in the Tinker AFB Fishing Proclamation available at Outdoor Recreation or Civil Engineering natural resources offices. Further discussion on the fishing program is located in Section 7.1.

Potential Class II areas include those areas identified as green infrastructure (except airfield, golf course, and extreme southeast portion of Tinker AFB) in the Green Infrastructure Plan (Tab 1). These areas could be developed for recreational activities such as jogging, biking, angling, and wildlife watching.

Class III areas: *special interest areas* which are defined as recreation areas that contain valuable archeological, botanical, ecological, geological, historic, zoological, scenic, or other features that warrant special protection and access control.

Tinker AFB has one Class III recreation area designated as a special natural area because of the presence of unique natural resources. A portion of Reserve 3 of the Urban Greenway has been designated as a Registered Natural Heritage Area through the Oklahoma Biological Survey. This area has been recognized for voluntary protection and preservation of the Texas horned lizard, a state-protected species. This area also has a 10-acre remnant native mixed-grass prairie.

This special natural area is managed by the Civil Engineering Directorate (natural resources function). Specific planned improvements and management activities for the area are identified in the Green Infrastructure Plan (Tab 1) and Section 8. Rules of conduct are the same as listed above for the Class II areas.

Also, although not classified as Class III recreational areas, several archeological sites have been identified on Tinker AFB involving wildlife fossils. Fossils unearthed on Tinker AFB property in recent years include: 1) immature bison humerus, 2) bison mandibles, and 3) horse molars (15th century or Ice Age). Bison mandibles are curated at the Museum of the Great Plains in Lawton, Oklahoma. The horse teeth are located in the Civil Engineering Directorate natural resources office. These archeological sites were small and isolated and therefore did not provide on-site recreational opportunities. For more information on these archeological sites, refer to the Tinker Air Force Base Integrated Cultural Resources Management Plan (Tab 6).

User access to recreational areas is limited to the following participant categories:

- Active duty military and members of the Guard and Reserves in active drilling status
- Military retirees
- Department of Defense civilians
- Department of Defense civilian retirees
- Employees of installation prime contractors (defined as a contractor with a five year or more term contract)
- Authorized dependents and family members in accordance with base guest/sponsorship requirements
- General public in accordance with base guest/sponsorship requirements

User access to the general public is restricted to the guest/sponsorship policy due to 1) base requirements necessary to ensure military safety and security and 2) intensive public use being inconsistent with natural resources use goals and objectives.

Off-road vehicle (including mountain bikes) use for recreational purposes is currently not permitted on Tinker AFB, but may be considered upon request. Off-road vehicle use for military training purposes is permitted but must be closely coordinated in advance and monitored by the Civil Engineering natural resources function. Permitted off-road vehicle use must comply with Executive Order No. 11989, *Off-road Vehicles on Public Lands*, May 24, 1977. Also, all motorized off-road vehicles must be licensed and insured as appropriate.

Outdoor Recreation Management Actions in Response to Climate Change

Little, if any, changes due to climate change are expected to occur regarding outdoor recreation and public access to natural resources on TAFB. Recreational activities such as use of the Urban Greenway, multi-use trails, golf course, sports fields, FAM Camp and picnic tables should continue without any effect. Hunting and fishing opportunities will need to be assessed on a regular basis. Opportunities will need to be based on assessment of health of fish and wildlife communities.

7.3 Conservation Law Enforcement

Applicability Statement

This section applies to all AF installations that maintain an INRMP. The installation is required to implement this element.

Program Overview/Current Management Practices

Fish and wildlife law enforcement needs have been limited in past years. However, as Tinker's natural resources have developed and the fishing program has grown, this need has become more apparent. The only procedure currently in place for enforcement of fish and wildlife laws on-base would be cooperation through the USFWS Law Enforcement Division located in Oklahoma City. This is due to specific training requirements for fish and wildlife law enforcement. The Installation Commander may designate fish and wildlife law enforcement authority to military or civilian personnel only if the person has either been certified in conservation law enforcement through training at the Federal Law Enforcement Training Center (FLETC) or by commission as a fish and wildlife conservation officer in the state where the installation is located (AFI 32-7064). In addition, cooperation with civilian law enforcement officials is addressed under DODI 5525. This requires prompt transfer of relevant information and allows cooperation with law enforcement agencies for certain assistance as outlined in Enclosure Four (DODI 5525 E4.1.1).

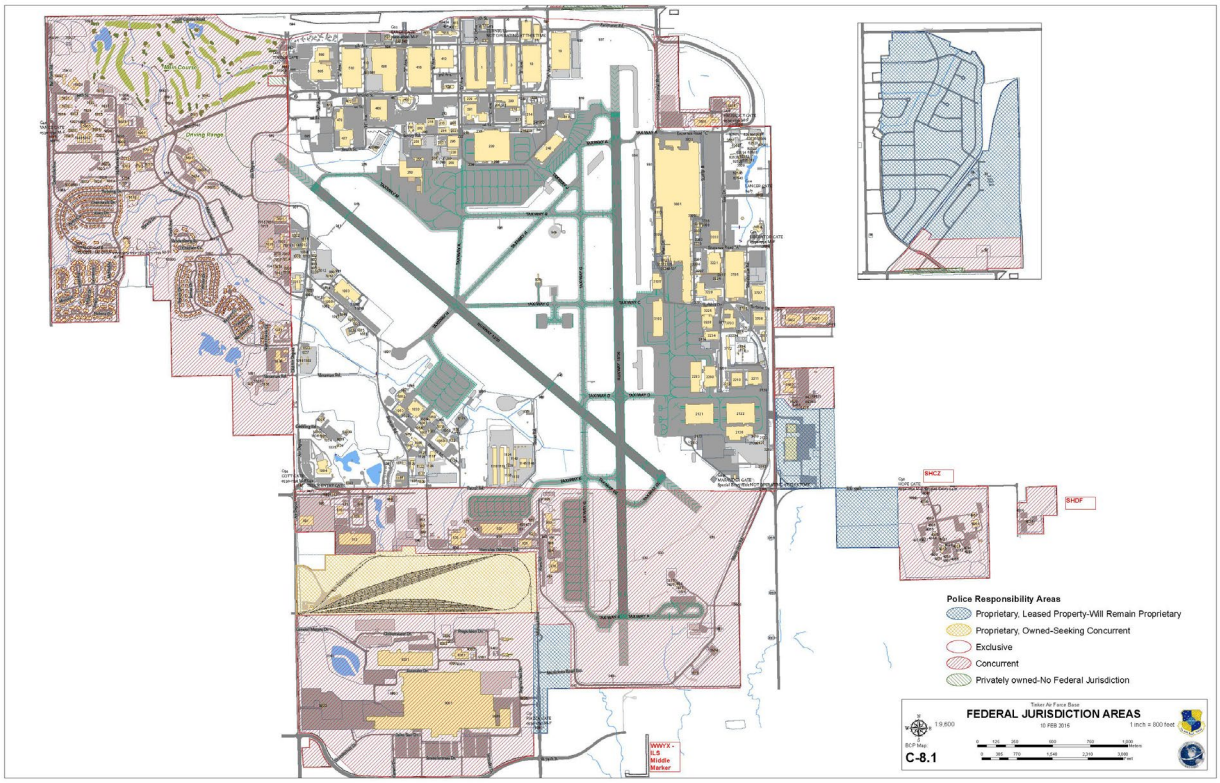
Angler survey and interviews of local anglers indicated a need for enforcement of creel limits that were at times being ignored by anglers. As a result, natural resources staff began permit and creel monitoring of anglers in 2009 (see table below). That year, twenty-nine of forty-four anglers were found to be compliant with Tinker AFB fishing permit requirements, and all anglers checked were found to be compliant with creel limits. The table indicates that as anglers were consistently checked compliance increased. It has also been noticed that when creel checks were conducted that permit sales increased. As a result, a courtesy permit check system has been implemented in the field. If anglers do not have their permits, they are instructed on how they can obtain them through "tinker.isportsman.net." On follow-up checks, if the angler is non-compliant, Security Forces is contacted and the angler may be escorted off base and/or reported to his immediate supervisor by Security Forces. Enlisted personnel can also be detained for non-compliance with base regulations or commander's orders (per Security Forces Instructions). It is evident that consistent monitoring has increased permit compliance.

Angler Permit Checks: Anglers were surveyed to determine whether they had appropriate licenses and permits to fish on the base.

Fiscal Year	Anglers Checked	Anglers Compliant	Percentage Compliant
2009	44	29	66%
2010	8	5	63%
2011	6	3	50%
2012-14	0	0	no checks
2015	17	21	81%
2016	95	74	77%
2017	44	32	72%
2018	69	57	82%
2019	42	39	92%

If wildlife law enforcement issues emerge such as deer poaching, illegal takes of migratory birds, or other violations, the appropriate agency (e.g., USFWS or ODWC) will be notified for enforcement. This would be dependent on the land jurisdiction where potential violations occurred per the map below. It might be noted that the only area that USFWS enforcement wouldn't have jurisdiction is on the Kuhlman cemetery located in the north central portion of the base.

If illegal plant substances such as *Cannabis* spp. were encountered on base, the Air Force Office of Special Investigations (AFOSI) would be notified immediately. If it were after hours, Security Forces would be notified who would patch through to the AFOSI on-call duty agent. AFOSI would respond to test the substance and dispose of properly.



Federal Jurisdiction Areas

7.4 Management of Threatened and Endangered Species, Species of Concern and Habitats

Applicability Statement

This section applies to AF installations that have threatened and endangered species on AF property. This section **is** applicable to Tinker AFB.

Program Overview/Current Management Practices

Fauna

For base management purposes, the term species-at-risk (SAR) denotes those species federally listed as threatened or endangered by the USFWS, state listed as threatened or endangered or species of concern or species of greatest conservation concern in Oklahoma County by ODWC (2011), and/or otherwise listed as a vulnerable (S3), imperiled (S2), or critically imperiled (S1) species by NatureServe (2011). NatureServe is a resource comprised of a network of natural heritage programs, including the Oklahoma Natural Heritage Inventory, and is a leading, comprehensive source for information regarding rare species and their habitats. NatureServe gives species and natural communities two ranks: a global (G) rank reflecting its rarity throughout the world and a sub-national/state (S) rank reflecting its rarity within specific states/regions. NatureServe rarity rankings have no regulatory stature but often times these rare species are found on federal and/or state listings, as candidate species for listing, or may have state laws protecting

them (for example, the Texas horned lizard). These rankings have been used to aid Tinker AFB biologists in developing and prioritizing species and natural community management objectives.

With six major taxonomic inventories of fauna accomplished to date, a total of 48 species at risk (SAR) have been documented on Tinker AFB (see Sensitive Species Table, Appendix I). The majority of these were birds; however, five mammals, one amphibian, one fish, and two reptiles are represented. Considering the number of species occurring and varying habitat requirements, a holistic ecosystem approach for management of these species has been developed. First, preferred habitat requirements for breeding, migratory, and resident Tinker AFB SARs were identified. Secondly, these requirements were cross-walked to Tinker's vegetative cover map creating a SAR Preferred Habitat Layer. Finally, SAR occurrences were mapped using GIS on the habitat layer to verify and truth the layer

Avian SARs listed as exclusively migratory within the central portion of Oklahoma were excluded from the analysis due to their relatively short and sporadic occurrences on Tinker AFB and their lack of reliance on Tinker AFB for resident or breeding habitat. As a management principle, exclusively migrant avian species and airfield-specific environments were eliminated from the layer as Tinker AFB does not desire to attract migratory birds to the airfield environment due to Bird Aircraft Strike Hazard (BASH) risks. Habitat located on and immediately adjacent to the airfield is managed to decrease wildlife diversity and abundance while areas further away from the airfield are managed to increase wildlife diversity and abundance. Attention is given to ensure wildlife in these latter areas do not pose increased BASH risks through daily migration patterns that may occur. A recent survey (St. Germain, 2010) of avian species on Tinker AFB concluded that the density, species richness, and species diversity are much lower on the airfield than within other areas located on Tinker AFB. This indicates that current management practices are successful in decreasing bird diversity and abundance on the airfield while increasing diversity and abundance on other areas on Tinker AFB (St. Germain, 2010).

The State of the Birds (North American Bird Conservation Initiative, 2011) report identified grasslands as the least protected and managed habitat type on public lands, with only 2% of grasslands in the United States being both publically owned and primarily managed for conservation. Grasslands and/or savanna (grasslands mixed with scattered trees) are a preferred habitat type for 21% of Tinker's SAR (see Appendix I). Several areas of dense invasive species monocultures (5.07 acres of lacebark and Siberian elm woodlands), which have little value to native and sensitive fauna, have been removed. These areas are being converted to native prairie/savanna habitat types. This will increase the value of these land parcels for all wildlife occurring on Tinker AFB, especially for the 21% of sensitive fauna which prefer grassland/savanna habitats. Twenty-nine Tinker AFB SAR prefer woodland, riparian woodland, open woodland, or woodland edge habitat. Currently 217 acres of this habitat type occurs on Tinker AFB. Efforts are underway to improve the quality of these woodland habitats through mechanical removal of invasive trees and shrubs, woodland thinning, and prescribed burning. Twenty-four Tinker AFB SAR require water or prefer habitat near aquatic resources. Tinker AFB contains numerous ponds and two major creek systems within its boundaries, thus creating 239 acres of suitable habitat for these species. Tinker AFB adheres to strict storm water and water quality guidelines which help ensure the health of these resources. SAR preferred habitat identified in the GIS layer will take precedence during planning of habitat management activities, and special considerations will be made during construction and community planning activities. This will allow Tinker AFB to properly balance the natural and built environment with its mission and allocate resources to appropriate areas thereby optimizing habitat improvement according to SAR habitat needs.

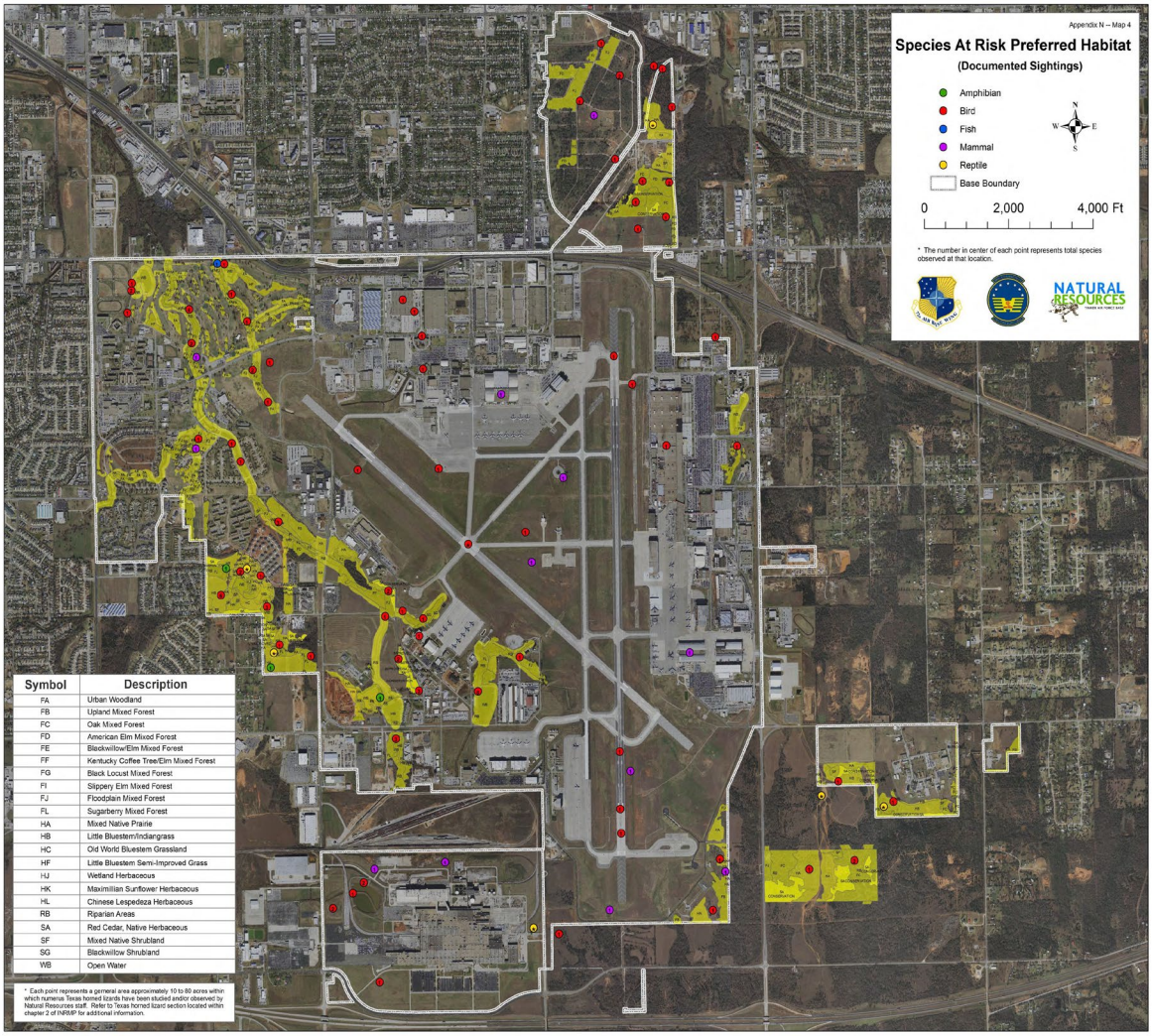
One federally threatened species, the piping plover (*Charadrius melodus*), has been documented at Tinker AFB. This plover was found dead on Runway 36/18 on 11 May 2009, the result of a bird-aircraft strike.

U.S. Fish and Wildlife Service (USFWS) and Oklahoma Department of Wildlife Conservation (ODWC) officials were contacted, and the plover was sent to verify identification. No other piping plovers have ever been observed loafing or foraging on Tinker AFB property before or after this strike. Base habitat is not managed to attract plovers.

Currently, if a piping plover or other federally listed threatened or endangered species were encountered that was impeding aircraft flying operations (i.e., planes not allowed to takeoff or land due to possibility of taking a threatened or endangered species) on the airfield, Tinker biologists would contact the USFWS Tulsa Ecological Field Services Office to request permission to haze the bird. Hazing would consist of such things as slowly driving a vehicle toward the bird to persuade it to move off the taxiway, runway, or ramp area. Other non-lethal means such as, but not limited to, honking, pyrotechnics, and propane cannons may also be used to move stubborn birds off the aircraft movement area. To further ensure Tinker's actions do not jeopardize the existence of a listed species and to ensure proactive measures (as opposed to the reactive measures stated above) are in place to limit negative impacts to the base's flying mission, USAF regional managers have completed a Biological Evaluation and intend to enter into Section 7 consultation for threatened and endangered species within the Central Flyway.

Three other threatened and endangered species—the least tern (*Sterna antillarum*), red knot (*Calidris canutus rufa*), and whooping crane (*Grus americana*)—are listed by the USFWS IPaC Report as potentially occurring in the Tinker AFB area but have not been observed on or flying over Tinker AFB. However, least terns have been observed at Lake Stanley Draper approximately 1 mile south of Tinker AFB. And, Tinker has many large, gravel-topped buildings which provide potential nesting habitat for terns. Terns have been documented nesting on graveled rooftops at other military installations such as Little Rock AFB. Therefore, periodic monitoring for terns on select rooftops (e.g., B-3001, Building 9001) will be conducted on Tinker.

While protection of SAR habitat is key to management, much can be discerned from the study and observation of such species on a military installation. The health and condition of SAR's are often a good indicator of ecosystem health.



Species at Risk (SAR) Preferred Habitat Layer: SAR preferred habitat identified by yellow-green GIS layer; alpha symbols indicate the vegetative cover type; colored points identify SAR sighting locations by animal class; numbers in points represent the number of species observed at each location (each point represents a survey area of 10-80 acres)

Texas Horned Lizard Management

The Texas horned lizard (*Phrynosoma cornutum*) is an Oklahoma state species of special concern (S2) and is listed as a state threatened species in Texas. It has a closed season in Oklahoma, making it unlawful to kill, capture, keep as pets, or sell Texas horned lizards (Oklahoma Administrative Code 800:25-7-8). Under Title 29 Oklahoma Statutes, Section 7-502, a person violating this statute is subject to a fine not less than $100 nor more than $500, or by imprisonment not to exceed 30 days, or both. The ODWC was petitioned to determine whether the lizard warranted state listing as an endangered species. In 2017, an ODWC-appointed technical committee of experts which included Tinker's staff biologist determined that sufficient evidence didn't exist to warrant listing.

The lizard has experienced declines throughout its range, but particularly in Texas (Price, 1990) and Oklahoma (Carpenter, et al., 1993). Factors suggested as causative of this decline include insecticide use (direct and indirect), effects of the red imported fire ant (*Solenopsis invicta*), habitat alteration for other

land uses (e.g., agriculture, development), roadway mortality, and commercial exploitation (Price, 1990; Donaldson, et al., 1994).

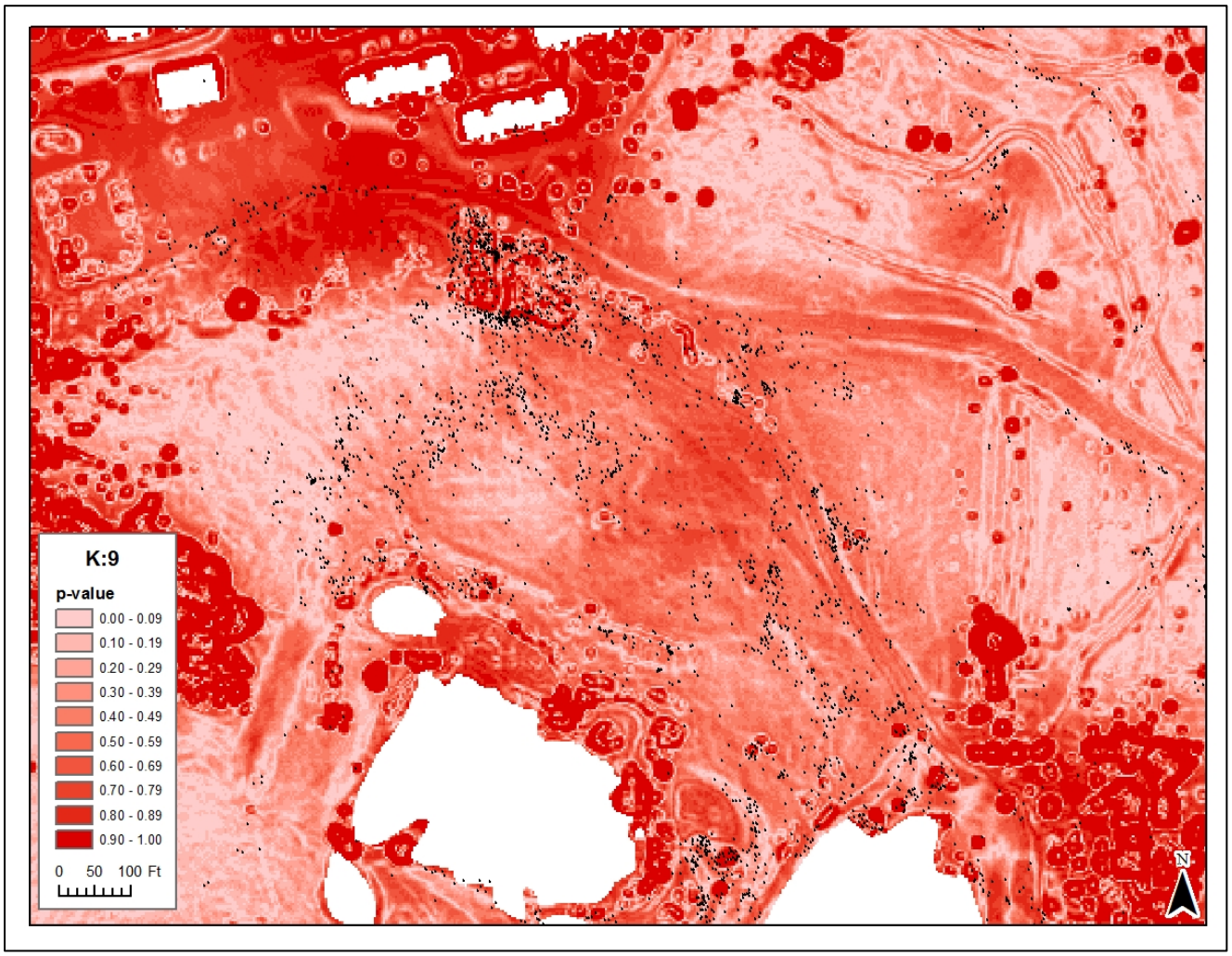
Texas horned lizards occur primarily in the southwest corner of Tinker AFB with isolated pockets in the southeast and Glenwood Area where the lizards' preferred habitat—a mosaic of grassland and bare ground areas—is present. This species is known to decline in abundance following urban and agricultural expansion. However, due to the small spatial requirements of the horned lizard, populations can survive in protected areas within urban settings such as Tinker AFB.

Working cooperatively since 2003, biologists and researchers from Tinker AFB, Southern Illinois University, Oklahoma State University and the University of Oklahoma have conducted life history and demographic research on the Texas horned lizard (Moody, Hellgren, Schauber, Siler, Watters, Bogosian, Wolfe, Mook, Vesy and Endriss, 2003-2019). During this time, four master's theses and one doctoral dissertation have been completed. Objectives of this study have included quantifying lizard distribution, habitat use, life history characteristics, and behaviors and developing relocation/husbandry techniques, new tracking technologies for hatchlings and adults, and ways to monitor lizard population trends. Radio telemetry and harmonic radar have been used to collect habitat use data, home range sizes, seasonal movement patterns, and survival rate data within and around Reserve 3 of Tinker's Urban Greenway. Data was collected using hand-held Trimble Units equipped with Global Positioning System (GPS) technology and was differentially corrected and imported into a Geographic Information System (GIS) layer and database for the horned lizards. The GIS layer has data (e.g., home ranges, hibernation sites, morphological data, habitat characteristics, and nesting locations) for over 1000 lizards with over 60,000 capture/relocation points overlaid on a high resolution, digital, color aerial photographs (GeoDatabase, 2019). Most recently, research has examined hatchling biology, translocation, and modeling of preferred habitat (see figures, "Texas Horned Lizard Habitat Suitability Model" and "2005 Light Detection and Ranging [LIDAR] Image of Preferred Hibernation Habitat") to assist with potential mitigation if needed for horned lizard conservation. Additionally, a major focus of this research has been to share information learned to aid horned lizard conservation efforts across its range. Research findings have been published in multiple scientific and professional journals (see table, "Summary of Texas Horned Lizard Research Findings at Tinker AFB").

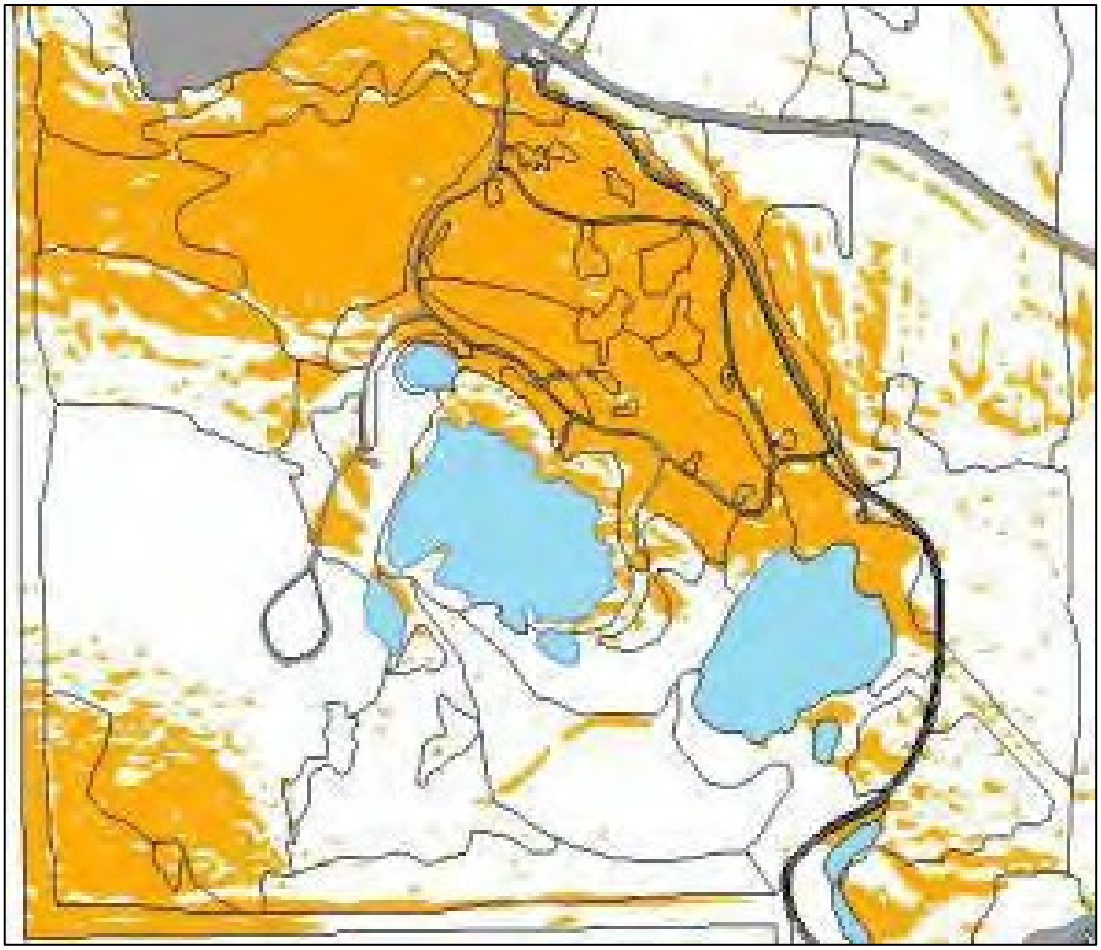
It is evident from the aforementioned research that the Tinker AFB Texas horned lizard population is established and likely in good health, but with many landscape level changes occurring, population densities have fluctuated. The most recent data shows lizard densities are increasing (see table, "Summary of Texas Horned Lizard Research Findings at Tinker AFB") on base. Continued monitoring and research of this SAR is key to proper management and vital to its survival on Tinker and across its range. This would lessen the potential for federal or state listing as a threatened or endangered species, thereby, precluding potential land use restrictions or other regulatory burdens on the military and other land owners.

Summary of Texas Horned Lizard Research Findings at Tinker AFB:
Results from a summary of cooperative research findings for the Texas horned lizard over an eight year period.

Summary of Texas Horned Lizard Research Findings at Tinker AFB			
Morphology			
	Hatchlings	*Juveniles*	*Adults*
Length (total)	27-51 mm	56-74 mm	86-93 mm
Weight	< 1 g	5-12 g	14-20 g
Males are consistently smaller than females, and lizards in northern latitudes are smaller than those in southern latitudes (i.e., diverges from Bergmann's Rule)			
Demography			
	Mating	*Nesting*	*Hatching*
Reproduction	May	June	July-Aug
	- Nests 5.0-7.5 cm depth - Clutches of 13-20 eggs; mean clutch size was 17; double-clutching recorded in 2011		
Maturation	- Sexually mature and reproduce in second year		
Incubation	- 7 – 10 weeks		
Survival rates	- adults 0.47; juveniles 0.25; and hatchlings 0.33 (TWS, Wolf, 2011)		
Ecology			
Habitat	- Mosaic of vegetation and bare ground (structure important for thermoregulation) - Utilize pond and marsh edges, close association to nature trails and other edges		
Temperatures	- Prefer 24-33° C or 75-91° F (typically 0800-1300 hours in summer months)		
Hibernation	- Enter Sept to Dec and emerge in early Apr; shallow 3-12 mm hibernacula; grassy S-SW facing slopes, <5-30 ° slopes (see Figure 2005 LIDAR Image of Preferred Hibernation Habitat)		
Home ranges	- 0.5-0.87 ha (~1-2 acres); males have larger home ranges than females		
Diet	- Primarily myrmecophagous (i.e., composed of ants); 12 different genera of ants out of 17 genera present (n=73); preference to *Crematogaster, Phiedole, Fomica*		
Territoriality	- Limited basis if at all; during the nesting season they demonstrate avoidance of one another; possible chemical signaling to limit displays of territoriality		
Pop. Densities	- 53 (± 11) individuals in Reserve 3; 5.0 lizards/ha (2005) Jolly-Seber Mod-MARK - 41 (95% CI:4-78, sample size n=8) individuals (2010) - 33 (95% CI:28.1-49) individuals (Closed captures in Program MARK 2011) - 17.71 individuals (+) 5.52 SE; 95% Cl 13.2-40.1 (2014) - 31.21 individuals (+) 13.59 SE; 95% Cl 18l.9-82.8 (2015) - 54.5 individuals (±) 21.5 SE; 95% CI 32.4-128.7), 3.56 lizards/ha, (2016)		
Habitat Model	- Important variables: bare ground, shrubs or improved grass (see Figure Texas Horned Lizard Habitat Suitability Model)		



Texas Horned Lizard Habitat Suitability Model: Above is the Texas horned lizard habitat suitability model D2 (K:9), and 2003-2008 individual lizard tracking points (note small dark points in background) on Reserve 3 of the Urban Greenway. Pink to lighter red indicates habitat more preferable to horned lizards based upon multiple habitat values of the model. Red areas indicate less favorable habitat. White space areas are cut-outs for water bodies and buildings. This model and several others were generated as a result of Bogosian's (2008) research and dissertation on the Texas horned lizard on Tinker AFB. This particular model emphasized variables for bare ground and vegetative structure.



2005 Light Detection and Ranging (LIDAR) Image of Preferred Hibernation Habitat: View of Reserve 3 in extreme SW portion of Tinker AFB. Orange shading indicates a GIS layer of preferred hibernation habitat features.

Fauna (Sensitive Species—Texas horned lizard))

Status

Trend

Metric: Status and trend of the Texas horned lizard is tracked by survival and density estimates using radio-telemetry and mark-recapture studies. Data in 2016 indicated the horned lizard population status is healthy with a population of 54 lizards within Reserve 3 of the Urban Greenway. Estimates indicate population trend is upward (recovered from 41 estimated in 2010 and 33 in 2011, using program MARK). Survival rates have also been similar over the last 12 years of study (i.e., ranging from 0.38-0.77).

Flora

Oklahoma penstemon colonies were originally identified and mapped on Tinker AFB during the 1992 flora inventory (Glenn et al., 1993). Two distinct populations were identified—one on the airfield and one on the Leased Training Area (LTA; the leased training area, sometimes referred to as Douglas Field, consisted of 80 acres of natural area southwest of CEIG; this lease was terminated in 2013). Colonies were remapped during the 1994 native tallgrass prairie assessment (Johnson et al., 1995). Both of these initial mappings were manually digitized. Recurring studies in 2005, 2006, and 2009 documented penstemon colony densities and used Global Positioning System (GPS) and Geographic Information System (GIS) technologies to survey and map penstemon populations (Dorr et al., 2005; Dorr, 2007; Dorr & Germain, 2010).

Penstemon density data was collected only for the colonies located on the airfield during the 2005 study (Dorr et al., 2005). The average size of all penstemon colonies mapped in 2005 was 4578.3 square meters (1.13 acres). Within the airfield the average penstemon colony size was 109.3 square meters (0.03 acres), and the average number of plants per colony was 28, with a maximum of 91 and a minimum of 1 plant per colony. A total of 251 individuals were documented (see figure, "Tinker AFB Total Penstemon Population by Area").

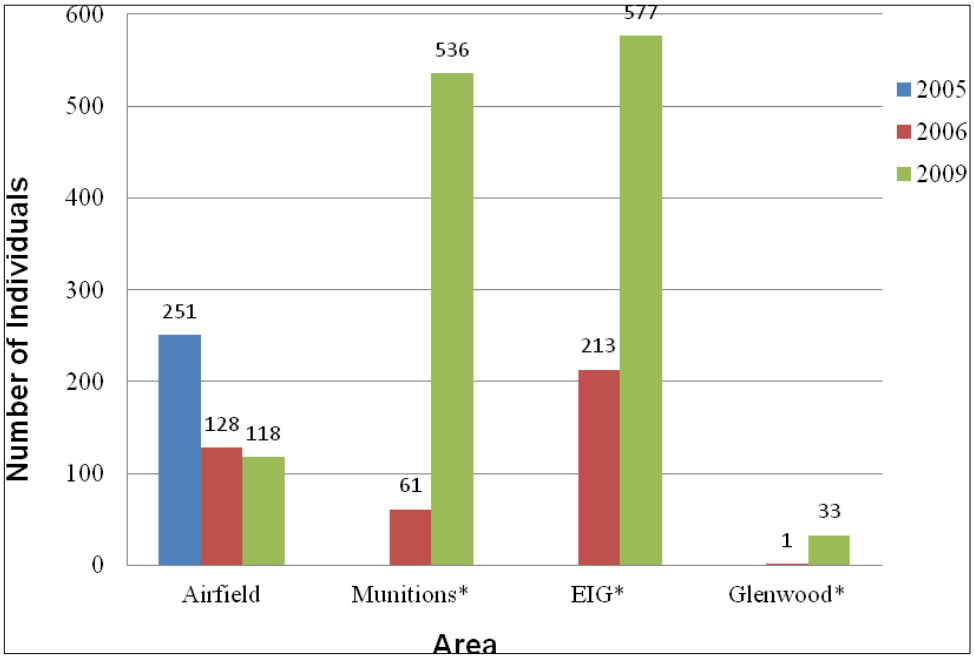
A total census of known Oklahoma penstemon colonies on Tinker AFB was conducted in May 2006 (Dorr, 2007). Locations containing penstemon colonies included the airfield, munitions, CEIG (formerly EIG), LTA, and Glenwood (see figure, "Tinker AFB Total Penstemon Population by Area"). The total size of penstemon colonies mapped in 2006 was 20,391.9 square meters (5.04 acres). The census found that the average colony encompassed 679.7 square meters (0.17 acres). The average number of plants per colony was 13, with a maximum of 63 and a minimum of 0 individuals per colony. A total of 403 individuals were documented. Penstemon colonies primarily occurred within Mixed Native Prairie or Mixed Native/Nonnative Prairie vegetation types (57.8%).

A total census of known Oklahoma penstemon colonies on Tinker AFB was conducted in May 2009 (Dorr and Germain, 2010). Locations containing penstemon colonies included the airfield, munitions, CEIG (formerly EIG), LTA, and Glenwood. A small population of penstemons located east of the Consolidated Fuels Facility (B-3902), which were not included in past studies, was lost in 2009 due to the construction of Building 3907. The total size of penstemon colonies mapped in 2009 was 61,395.7 square meters (15.17 acres). The census found that the average colony encompassed 2273.9 square meters (0.56 acres). The average number of plants per colony was 42, with a maximum of 382 and a minimum of 0 individuals per colony. A total of 1264 individuals were documented. Penstemon colonies primarily occurred within Mixed Native Prairie or Mixed Native/Nonnative Prairie vegetation types (45.7%).

Temporal variation of penstemon colonies is likely influenced by precipitation and mowing schedules. Historically, penstemon populations have not been managed except by maintaining no-mow zones in select areas until after penstemon seed dispersal in late May. Because of potential conflicts with flight operations (i.e., creation of bird/wildlife strike hazards), the areas where penstemon populations occurred within the airfield fence boundary southeast of the crosswind runway are no longer maintained as no-mow zones in the spring months. Unless these populations can tolerate repeated spring mowing, it is expected these populations will be lost over time.

Beginning in 2009, Tinker AFB began a multi-year research project on the penstemon through a cooperative agreement with the University of Oklahoma. The project entitled *"Life History and Management of the Oklahoma Beardtongue"* was designed to gather scientific data which supports understanding penstemon life history and population dynamics under natural and varying anthropogenic disturbance regimes so as to 1) better equip the military in making land-use decisions associated with this sensitive species; 2) ensure

land-use flexibility for military activities; and 3) ensure sustainable penstemon populations in the region. Several peer-reviewed articles were published from this research (refer to Section 11, Installation References).



*Areas not surveyed during the 2005 study

Tinker AFB Total Penstemon Population by Area

Flora (Sensitive Species)

Status

Trend

Metric: Status and trend of the Oklahoma penstemon is tracked by periodic monitoring of penstemon colony densities using standardized techniques used by Virginia Tech University (Dorr et al., 2005; Dorr, 2007; Dorr & Germain, 2010). The target census cycle is every three years. Based on 2009 Oklahoma penstemon monitoring on Tinker AFB, the current population status is considered GOOD and the trend is UPWARD. However, data has been collected for a relatively short period of time and has not been monitored since 2009; therefore, status and trend determinations are presented with caution, and censusing is needed.

7.5 Water Resource Protection

Applicability Statement

This section applies to AF installations that have water resources. This section **IS** applicable to Tinker AFB.

Program Overview/Current Management Practices

Proper water resources management is essential to Tinker's military operations. Compliance with water quality standards is important to ensure military operations, such as deicing aircraft and discharging of facility firefighting agents, are not hindered or restricted because of notices of violation with state and federal regulators. Water pollution is not only an indication of poor stewardship, but it also demonstrates irresponsibility and damages the public trust.

A 100- or 500-year flood event would significantly disrupt some of Tinker's military operations (see 500-Year Impact Map in Green Infrastructure Plan, Tab 1); therefore, proper management of floodplain and upland drainage areas (on- and off base) are critical. In a 100- or 500-year flood, airfield operations would remain functional.

Clean water in Tinker AFB streams and ponds adds significantly to warfighter quality of life through enhanced aesthetics and outdoor recreational opportunities such as fishing. Refer to Section 7.1, Sport Fishing, and the Green Infrastructure Plan (Tab 1) for additional information on the importance of Tinker's water resources and its connection to military readiness.

Surface Water (Streams and Ponds)

Tinker AFB discharges to stream systems are regulated under permits by the National Pollutant Discharge and Eliminations Systems (NPDES) and Storm Water Pollution Prevention (SWPP) programs. In 1996, Tinker AFB Industrial Wastewater Treatment Plant (IWTP) and Sanitary Treatment Plant (STP) discharges were rerouted to the Oklahoma City Public-owned Treatment Works. This eliminated secondary treated flows of 1.3 million gallons per day to the on-base portion of Soldier Creek (i.e., east Soldier Creek).

Although water quality has degraded since pre-settlement times, improvements have occurred over the last 30 years based on biological diversity surveys and weekly water quality monitoring. Tinker AFB collects and analyzes water samples from all Tinker AFB streams on a weekly basis. These samples are acquired to monitor compliance with Oklahoma Water Quality Standards assigned to each creek under the NPDES and storm water permits. In addition to analytical monitoring, other conditions are noted at each creek outfall during each field visit. These parameters include: clarity, algae growth, odors, presence of foam, and presence of oil sheen. All of these results and visual indicators are used to locate and eliminate illicit or harmful discharges.

Surface water degradation is primarily due to accidental spills and non-point source pollution. The most common examples include: sediment from soil erosion associated with construction/ demolition activities, automobile oil/fluid runoff from parking lots, runoff from areas treated with fertilizers and pesticides, chemical substances and fuel from spills associated with industrial and aircraft activities, and de-icing compounds from roadways, taxiways, runways, ramp areas, and aircraft. Some effects of these types of pollution include periodic fish kills which typically result from accidental chemical or fuel releases and de-icing.

Tinker AFB is considered to be a federal aviation facility and is therefore required by the Oklahoma Department of Environmental Quality (ODEQ) to possess storm water discharge permits. Tinker AFB has eleven permitted discharge points that fall into one of the following two permit categories: 1) National Pollutant Discharge Elimination System (NPDES) permit for source pollution or 2) construction site permit for all construction sites. Occasional NPDES permit exceedances and violations have occurred.

The latest Oklahoma Water Quality Standards (OWQS), as established by the Oklahoma Water Resources Board (OWRB, 1993), have designated beneficial uses for streams, named and unnamed on Tinker AFB.

Designated beneficial uses for listed surface water bodies are set out in Title 785 of the Oklahoma Administrative Code (OAC) Chapter 45, Appendix A. Water bodies present on Tinker AFB are listed in Appendix A, Table 5 of Title 785 of the OAC. Criteria for protecting surface water beneficial uses and the default beneficial uses for unlisted streams in Oklahoma are set out in Chapter 45, Subchapter 5, of Title 785 of the OAC.

Beneficial uses for the Soldier Creek tributary (referred to on Tinker AFB as East Soldier Creek), located at the NW ¼, Section 13, T11N, R2W, IM, which is a listed water body in OWQS (Waterbody ID No. 520520000290) include:

- Fish and Wildlife Propagation/Warm Water Aquatic Community (i.e., water bodies are capable of sustaining species development through all life stages),
- Agriculture/Livestock and Irrigation (i.e., toxicity will not inhibit continued ingestion by livestock or irrigation of crops),
- Industrial and Municipal Process and Cooling Water (i.e., process and cooling water quality criteria will be protected by application of the criteria for other beneficial uses),
- Secondary Body Contact Recreation, and
- Aesthetics (i.e., water is aesthetically enjoyable by being free from floating materials and suspended substances that produce objectionable color and turbidity. Water must be free from noxious odors, tastes, and materials that settle to form objectionable deposits and that produce undesirable effects or are a nuisance to aquatic life. Criteria to protect this use shall be color, nutrients, solids, taste, and odor).

The Crutcho Creek tributary at SW ¼, Section 16, T11N, R2W, IM, (Water Quality Management Segment No. 520520), a significant portion of which is off-base, has been designated with the following beneficial uses:

- Fish and Wildlife Propagation/Warm Water Aquatic Community,
- Agriculture/Livestock and Irrigation,
- Industrial and Municipal Process and Cooling Water,
- Primary Body Contact Recreation, and
- Aesthetics.

The primary portion of Crutcho Creek (Waterbody ID Nos. 520520000070_10 and 520520000090), which flows through the southern part of Tinker AFB, housing, community area, and golf course has been designated with the following beneficial uses:

- Habitat-limited Aquatic Community (i.e., water chemistry and habitat are not adequate to support a warm water aquatic community),
- Agriculture/Livestock and Irrigation,
- Industrial and Municipal Process and Cooling Water,
- Secondary Body Contact Recreation (i.e., activities where ingestion of water is not anticipated; for example, boating, fishing, and wading), and
- Aesthetics

Primary Body Contact Recreation is defined as recreation which involves direct body contact with the water where a possibility of ingestion exists. In these cases, water shall not contain chemical, physical or biological substances in concentrations that are irritating to skin or sense organs or are toxic or cause illness upon ingestion by human beings.

Secondary Body Contact Recreation beneficial use is designated where ingestion of water is not anticipated. Associated activities may include boating, fishing, or wading.

For additional information on surface water protection, refer the Green Infrastructure Plan (Tab 1) and Storm Water Management Plan (Tab 7).

Ground Water

Investigation and remediation of groundwater contamination has been ongoing at Tinker AFB for the past 25 years under the Air Force's Environmental Restoration Program. Some of the remediation technologies employed include ground water extraction, filtering, and reuse; bioremediation by injecting vegetable oil into contaminated ground water; and permeable reactive barriers to interrupt contaminated ground water migration. Today, all operations and disposal activities are governed by the Environmental Protection Agency (EPA), State of Oklahoma Department of Environmental Quality (ODEQ), or Oklahoma Corporation Commission (OCC) rules and regulations. This would include the Resource Conservation and Recovery Act (RCRA) and the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA).

Aquatic Resources (Groundwater)

Status ■

Trend ↑

Metric: There is no established metric for this resource. However, in general, the status of groundwater quality on TAFB is considered poor to good depending on location, and therefore has been given an overall rating of fair. Trend is upwards due to ongoing groundwater remediation projects.

Floodplains

Tinker's floodplains are governed by Federal Executive Order (E.O.) 11988, *Floodplain Management.* For more information on the restoration and protection of the natural and beneficial values served by floodplains, refer to the Green Infrastructure Plan (Tab 1).

Aquatic Resources (Floodplains)

Status ■

Trend ↑

Metric: A healthy floodplain is defined as one that will provide natural and beneficial functions and values such as reduced bank erosion, attenuation of flood peaks, quality fish and wildlife habitat, flood storage, enhanced aesthetics, effective filtering of pollutants, and others.

Although there is no established metric for this resource, the status of 100- and 500-year floodplain functions and values is considered fair based on field observations of TAFB natural resources staff. The trend is upward. The extent of potential flooding based on the current floodplain boundary delineations is essentially fixed due to floodwater detention pond requirements for all military

construction projects. Floodplain functions such as fish and wildlife habitat and water filtering have increased appreciably along the Crutcho Creek corridor due to the conversion of improved and semi-improved grounds to natural areas within the floodplain.

7.6 Wetland Protection

Applicability Statement

This section applies to AF installations that have existing wetlands on AF property. This section **IS** applicable to Tinker AFB.

Program Overview/Current Management Practices

Tinker's wetlands are governed by two mandates: 1) Section 404 of the Clean Water Act for jurisdictional wetlands and 2) federal Executive Order 11990, Protection of Wetlands, for non-jurisdictional wetlands.

In 2002, Tinker began wetland monitoring. The originally inventoried 65 acres (73 individual wetland areas) (see paragraph 2.3.5 for initial inventory information) were reassessed to track their status and trend (Wetland Study Report for Tinker AFB, Oklahoma, May 2003). Comprehensive assessments of wetland hydrology and habitat parameters were made on all NWI wetland sites using the Ohio Rapid Assessment Method for Wetlands (ORAM) (Mack, 2001). Intermittent and perennial stream habitats were further evaluated using the U.S. Environmental Protection Agency's Rapid Bioassessment Protocol (RBP) (Barbour, et al., 1999). These methodologies provided quantitative rating protocols which were used to rank the quality of each wetland site. Based on the survey, only two wetlands (i.e., Greenway and Prairie Pond) were classified as high quality wetlands. Thirty-four were classified as intermediate quality, and six as low quality. This study also determined that 33 of the original 73 NWI wetland areas no longer existed or were actually drainage ditches or wet-weather conveyances that did not function as wetlands or aquatic habitat. These non-wetland areas covered approximately 27 acres and most were within the airfield or other highly industrialized areas of Tinker AFB.

In 2007, SAIC conducted a five-year reassessment on 40 wetlands estimated at 38 acres (SAIC, 2008). The same protocols used in the 2002 assessment were used to determine the status and trends in these wetlands and to determine whether any wetlands on base had developed jurisdictional qualities. Twenty-five improved in quality (based on ORAM); 14 had no significant change; and one declined. The declining location was on East Crutcho Creek between the 507th and the airfield. It had little riparian vegetation due to airfield mowing requirements and suffered from high flow storm water events. Additionally in 2007, 21 streams and ponds were reassessed using the 2002 RBP scoring criteria. Ten streams/ponds had improved; 10 had no change; and 1 declined. The declining stream, formerly an unnamed tributary to Beaver Pond, was converted to a marsh filter (now named Beaver Marsh Filter Pond) to improve water quality in the Beaver Pond fishery. This newly created pond/wetland is expected to recover quickly from impoundment and quickly take on wetland characteristics that will continue to improve over time. All of the areas above were also evaluated for federal jurisdictional status. Of these, one located north of Fire Pond was determined to have jurisdictional qualities. Details are provided below on this jurisdictional wetland and others that are considered by the U.S. Army Corps of Engineers (USACE) as jurisdictional.

Tinker AFB Wetlands: Jurisdictional status, acreages, and quality rankings.

Jurisdictional Wetland	Quality Ranking+	Area (ac)
Currently Occurring		
Greenway	High	8.64
Fire Pond (below dam)	Intermediate	3.16
Historically Removed & Mitigated or Reclassified		
Fuel Control Facility (FCF) *	Intermediate	(0.8) removed (on-base) (1.0) mitigated (off-base)
Glenwood	High	(8.5) removed (off-base) (1.5) removed (on-base) (15.3) mitigated (off-base)
GWTP**	Intermediate	(0.63) removed IRP
Compressed Natural Gas (CNG)++	Intermediate	0.34 (pending USACE Doc)

** FCF wetland downgraded by USACE to non-jurisdictional just before draining; mitigation still required under E.O. 11990, Protection of Wetlands*

*** Soils removed as part of Installation Restoration Program (IRP) remediation of site under USEPA Jurisdiction*

+ Delineations & quality rankings from SAIC (2008) wetland study

++ CNG wetland downgraded by USACE to non-jurisdictional; wetland is now regulated under E.O. 11990, Protection of Wetlands

The table above describes the current jurisdictional status and history of classification of wetlands on Tinker AFB. Several of these jurisdictional wetlands have been removed, mitigated, or reclassified. In 1999, the Glenwood wetland [see figure, "Aquatic Resources (Wetlands) of Tinker AFB" in Section 2.3.5] was drained due to waterfowl attraction which presented an aircraft strike hazard. Mitigation for the Glenwood wetland removal included construction of wetlands in Choctaw, Oklahoma (two wetlands totaling 2.3 acres); McCloud, Oklahoma (one 3-acre wetland); Eagle Ridge Institute in Oklahoma City (one 3-acre wetland); and a Kids-We-Care site (three wetlands totaling 10 acres) located south of Guthrie, Oklahoma. Mitigation acreages are approximated. That same year, the Ground Water Treatment Plant (GWTP) wetland, which was located on a Superfund site under EPA jurisdiction, was removed as part of a Superfund cleanup action.

In 2011 a small wetland (0.8 ac) was drained to permit expansion of the Fuel Control Overhaul Facility. Mitigation for this project was developed through cooperative agreements with Land Legacy and Grove Valley Schools located in Edmond, Oklahoma. Mitigation created a 1.0-acre wetland under a conservation easement for Grove Valley School to use as an outdoor classroom. Tinker AFB, the school, NRCS, USFWS, and other agencies worked together in planning, designing, and planting aquatic vegetation in the spring of 2011 which resulted in a successful wetland development and mitigation project. However, in 2019, Deer Creek Schools requested that the Grove Valley mitigated wetland be relocated to school land at N. Meridian and 206th. The school has designed and plans to build an equivalent wetland meeting the same mitigation values. This would include Land Legacy placing a conservation easement on the new wetland site.

In 2016, the USACE reclassified the CNG jurisdictional wetland to non-jurisdictional. This brings the current total number of jurisdictional wetlands to two, comprising 11.8 acres (see figure, "Tinker AFB Wetlands").

Aquatic Resources (Wetlands, Streams, and Ponds)

Status

Trend

Metric: The status of Tinker's aquatic resources (which includes wetlands, streams and ponds) is good and trend is upward. This is based upon SAIC studies in 2002 and 2007 which compared ORAM and RBP scores of wetland quality. Improvements in wetland functions and values will be tracked by on-the-ground site visits/assessments every two years (odd years) and periodic (15-year; due in 2022) status and trend assessments which will be compared with the baseline and subsequent wetland quality rankings.

7.7 Grounds Maintenance

Applicability Statement

This section applies to AF installations that perform ground maintenance activities that could impact natural resources. This section **IS** applicable to Tinker AFB.

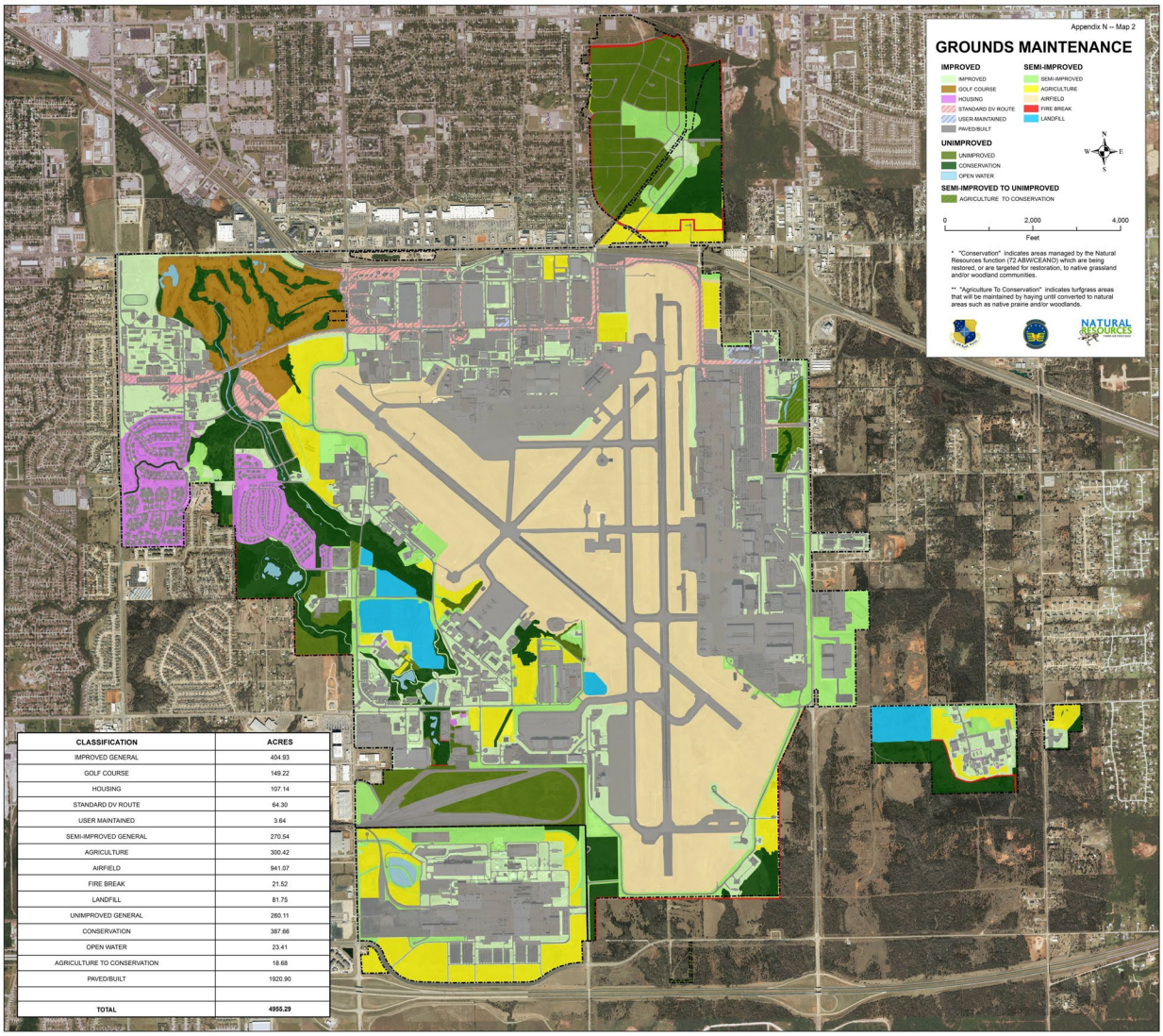
Program Overview/Current Management Practices

Tinker AFB grounds are classified into four basic categories:

1. **Improved grounds (paved/built)** – highly developed land occupied by buildings, roads, parking lots, runways, and other permanent structures.
2. **Improved grounds (turf/landscape beds)** – highly maintained areas such as lawns, athletic fields, golf courses, cemeteries, and landscape plantings on which personnel annually plan and perform intensive maintenance activities. Grass in these areas is normally maintained at a height of 2-4 inches during the growing season.
3. **Semi-improved grounds** – periodically maintained grounds where maintenance is performed primarily for operational reasons (such as erosion and dust control, bird control, and visual clear zones). This land use classification includes areas adjacent to runways, taxiways, and aprons; runway clear zones; lateral safety zones; rifle and pistol ranges; ammunition storage areas; antenna facilities; firebreaks, and golf course roughs. These areas are mowed less often to maintain grass height typically between 7-14 inches.
4. **Unimproved grounds** which are basically waterbodies and areas of relatively low mechanized vegetation maintenance. This includes areas which are managed by prescribed burning, tree thinning, invasive plant species removal, or similar conservation practices. Unimproved grounds are areas not classified as 'improved' or 'semi-improved'. Unimproved grounds include conservation areas such as natural woodlands, grasslands, ponds, wetlands, creeks, and other areas where natural vegetation is allowed to grow essentially unimpeded by maintenance activities.

Since 2007, Tinker AFB has increased in size by approximately 545 acres, primarily due to acquisition of the former General Motors, Burlington Northern-Santa Fe, and Twaddle properties and lease of the Maintenance, Repair, and Overhaul property. This change in acreage also includes the loss of 80 acres due to the termination of the Leased Training Area (east of Douglas Blvd. and south of SE 59th Street).

Grounds maintenance categories are graphically depicted in figure, “Grounds Maintenance Land Use Categories.”



CLASSIFICATION	ACRES
IMPROVED GENERAL	404.93
GOLF COURSE	149.22
HOUSING	107.14
STANDARD DV ROUTE	64.30
USER MAINTAINED	3.64
SEMI-IMPROVED GENERAL	270.54
AGRICULTURE	300.42
AIRFIELD	941.07
FIRE BREAK	21.52
LANDFILL	81.75
UNIMPROVED GENERAL	260.11
CONSERVATION	387.66
OPEN WATER	23.41
AGRICULTURE TO CONSERVATION	18.68
PAVED/BUILT	1920.90
TOTAL	**4955.29**

Grounds Maintenance Land Use Categories

Urban Forestry

Species and Age Diversity

The most common trees identified by Virginia Polytechnic Institute and State University in the 2007 Tinker AFB Urban Forest Inventory were the Eastern redcedar (*Juniperus virginiana*) (14%) and Austrian pine (*Pinus nigra*) (10%). According to Santamour’s species diversity model (Santamour 1990), less than 30% of the total population should be from a single family, less than 20% should be from a single genus, and less that 10% should be a single species. The population at Tinker AFB only exceeds the model with the single species *Juniperus virginiana*.

According to the primary age diversity model (Richards 1983), 40% of trees should be less than 20 cm (~8 in.) diameter at breast height (DBH), 30% of trees should be between 20 and 40 cm (~8-15 in.) DBH, 20% of trees should be between 40 and 60 cm (~16-24 in.) DBH, and 10% should be above 60 cm (~24 in.) DBH. As of the 2007 inventory, the urban forest at Tinker AFB was extremely close to these criteria. The 8-15 inch DBH class was just below 30%, at 29%, and the greater than 24 inch DBH class was just above 10%, at 11%.

The fundamental purpose of promoting species and age diversity in the urban forest is to ensure long-term stability of urban forest structure, function, and value. These models will be used on Tinker AFB as guidelines for species selection and timing of planting for new trees in the future.

In addition to species and age diversity, the presence of native tree species is important to urban forest sustainability and biodiversity. Therefore, a species composition objective has been established to increase native tree abundance while decreasing non-native tree abundance. This is being done primarily through attrition and by ensuring only native trees are used for new plantings. Based on the 2007 inventory, Tinker's native to non-native tree ratio was 1.32:1. Following tree loss due to the December 2007 ice storm, the ratio increased to 1.69:1 (many exotic, weak-wooded trees such as Siberian elm, lacebark elm, and Bradford pear were lost).

Percent Canopy Cover

As of 2007 (baseline year), the overall tree canopy cover for Tinker AFB, excluding the airfield where trees are not permitted, was 9.2%. Canopy cover for industrial, commercial, and residential areas was 2.2%, 13.9%, and 21.1%, respectively. At the time of this initial canopy cover determination, *industrial* was comprised of the following urban forestry management units (refer to Urban Forestry Management Procedures for map of Urban Forestry Management Units): 507th/513th, AWACS, AWACS Alert, CEIG (formerly EIG), Gator, Industrial East, Industrial North, Industrial South 1 through 6, Navy, and 3rd Herd. *Commercial* was comprised Community (Commercial) 1 and 2. *Residential* was comprised of Community (Residential—Military Family Housing), Golf Course, Munitions, and Open Space 1 through 3. In 2011, adjustments were made to these units by adding Industrial South 7 (Tinker Aerospace Complex comprising 406.6 acres); reducing Open Space 2 from 158.1 to 139.3 acres due to Medical Clinic construction; and expansion of Industrial South 4 from 45.5 to 64.1 acres due to Medical Clinic construction. In 2015, adjustments were made by adding the KC-46A site (previously Burlington Northern-Santa Fe property) to Industrial South 7 and by merging the defunct 3rd Herd with Industrial South 1. In 2017, the northern portion of Open Space 5 was redesignated as Industrial South 7 due to expansion of the KC-46A site.

In 2019, Davey Resource Group, in cooperation with the Oklahoma City Community Foundation, Oklahoma Forestry Services and the Association of Central Oklahoma Governments, completed the Central Oklahoma Tree Canopy Assessment. This assessment found that Tinker's tree canopy was 6.8%, a 25% reduction in canopy cover since 2007. From 2007 to 2019, Tinker lost over 3000 of its 6600 trees. This tree loss is attributed to a 2007 ice storm followed a few years later by a 239-week extreme drought, consequential disease and insect outbreaks, large scale construction projects and the removal of 50 acres of invasive cedars across the base. For more details, see "Recent Climatic and Ecologic Influences on Tinker's Urban Forest" below.

American Forests (a non-profit conservation organization dedicated to protecting and restoring healthy forest ecosystems) sets canopy cover goals for metropolitan areas in the Southwest and dry West as an overall coverage of 25%. This is further broken down to 35% for suburban residential areas (equivalent of Tinker's residential area described in previous paragraph); 18% for urban residential zones (equivalent of Tinker's commercial zone as described in previous paragraph); and 9% for central business districts (equivalent of

Tinker's industrial area as described in previous paragraph). Tinker AFB has adopted these percent canopy cover goals for the base.

Trees in Transitional and Approach-Departure Surfaces (Glideslope)

Trees can pose flight or glide slope instrumentation obstacles which in-turn could compromise flight safety. Accordingly, UFC 3-260-01 requires trees that project into the imaginary surfaces be removed or lowered a minimum of 10 feet below the imaginary surface. Trees are permitted near an airfield provided they are not in clear zones and do not penetrate imaginary surfaces, the taxiway clearance distance, the apron clearance distance, or instrument procedure obstacle identification surfaces as described in Terminal Instrument Procedures (TERPS) regulations.

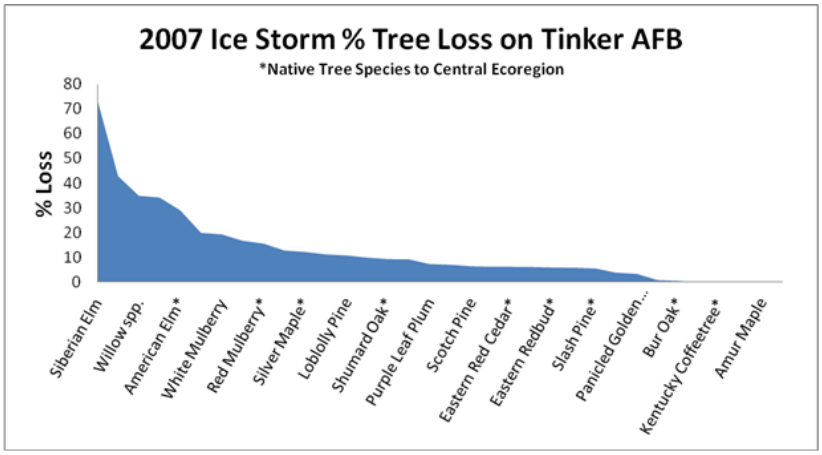
The 2007 urban forest inventory identified 182 trees which potentially breached the Transitional and Approach-Departure Surfaces. Natural Resources and Airfield Operations staff conducted a follow-up field assessment, and trees requiring removal were identified. Some, but not all, of these trees were removed. Some were left in place due to their proximity to buildings that in themselves breached the imaginary surface.

Natural Resources staff, in coordination with Airfield Operations, will assess trees every 5 years to determine violations of the abovementioned regulations. Findings and recommendations will be provided to Airfield Operations for further action.

Recent Climatic and Ecologic Influences on Tinker's Urban Forest

In December of 2007, Tinker AFB experienced a severe ice storm. Tinker's urban forest sustained major damage with cleanup costs exceeding $1M. Approximately 1035 trees [284 small (< 25'); 548 medium (25'-50'); 203 large (> 50')] were removed, and 2950 received corrective pruning. Street trees, which are typically scattered or isolated across the landscape, received the most damage. Trees located in the interior of dense tree stands sustained little damage (due to interlocking support of ice-covered branches), whereas trees on the fringes of these stands sustained more substantial damage (see figure, "Percent Tree Loss Due to 2007 Ice Storm").

In 2010, numerous eastern redcedars and pines were lost base-wide due to severe infestations of bagworms and pinewood nematodes, respectively. In 2014, another bagworm outbreak occurred to the extent that bagworms uncharacteristically infested many deciduous trees such as sycamores, redbuds, and elms. These outbreaks were the worst observed in 20 years.



Percent Tree Loss Due to 2007 Ice Storm

Forest Product Sales

Although Tinker does not manage commercial forests, many felled urban trees can provide marketable products such as firewood and furniture/craft wood. These trees can also serve other purposes such as fish and wildlife habitat structure in ponds. Diversion of landfill waste is one of the primary benefits of forest product salvage and use.

DOD and AF instructions specify that marketable forest products shall not be given away, donated, abandoned, carelessly destroyed, used to offset contract costs, or traded for services, supplies, or products, or otherwise improperly removed. To comply with this requirement, Tinker began selling forest products in 2011 (furniture and smoking wood), and in 2015 expanded with routine sales of mixed firewood.

Grounds maintenance and construction/demolition contractors are required by contract boilerplate specification to haul intact trunks/large branches or to limb, buck, and haul felled trees to the base's forest products staging area. At this site, firewood is processed for sale by conservation staff and volunteers.

Local market research was accomplished to set firewood pricing. Firewood is sold to on- and off-base buyers. Generated funds are deposited into the U.S. Treasury and are available for use by the Tinker conservation program through the Air Force's reimbursable forestry program.

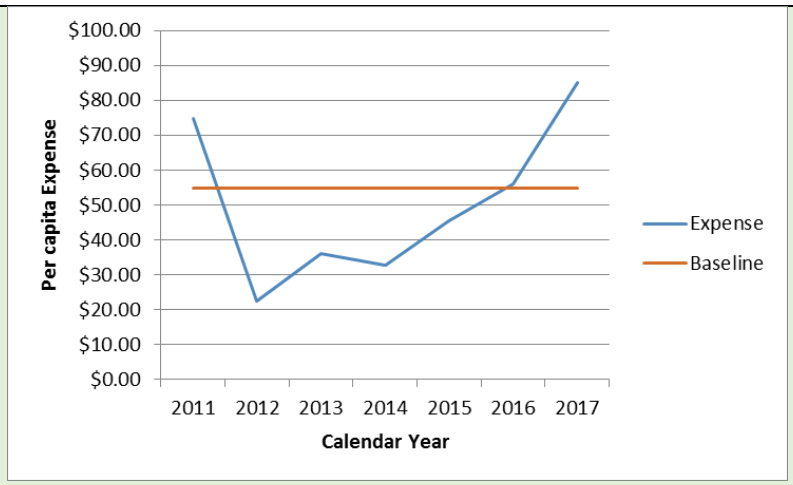
Flora (Urban Forestry)

Status ■

Trend ⬌

Metric 1: Percent tree canopy cover is used as an index to environmental quality improvement. Tracking this metric is accomplished by 15-year recalculations (due in 2022) of the percent canopy cover. The baseline (established 2007) overall percent canopy cover for Tinker AFB is 9.2%. By area, baseline percent canopy cover for industrial, commercial, and residential areas is 2.2%, 13.9%, and 21.1%, respectively.

Metric 2: Measuring efficiency of urban forest management practices on Tinker AFB will be tracked by the annual per capita expenditures for urban forestry activities. Per capita expenses are based on Tinker AFB population (military family housing and dorm residents), not the workforce. Implementation of Urban Forestry Management Procedures (Appendix G) should lead to a downward trend in annual expenditures over time. The average per capita expense from 1993 through 2005 was $54.82 which serves as the baseline.



Metric 3: Measuring effectiveness of urban forest management as it relates to flight safety will be measured by conducting targeted tree height surveys at 5-year intervals (due in 2020). UFC 3-260-01 requires trees that project into the imaginary surfaces be removed or lowered a minimum of 10 feet below the imaginary surface. Trees are permitted near an airfield provided they are not in clear zones and do not penetrate imaginary surfaces, the taxiway clearance distance, the apron clearance distance, or instrument procedure obstacle identification surfaces as described in Terminal Instrument Procedures (TERPS) regulations.

The status and trend of Tinker's urban forest is FAIR and STABLE, respectively. Although some progress (e.g., implementation of tree permit system; tree care workshops; partial implementation of Urban Forestry Management Procedures) has been made in urban forestry management in recent years, several setbacks have been experienced. Since 2007, over 800 trees were planted on base; however, due to the 2007 ice storm, the 2010 and 2014 insect and disease outbreaks, and 2011 and 2012 droughts, and tree removals in military family housing to permit construction of new houses, more than 1100 trees (~1/6 of Tinker AFB tree population) were lost. Many of these were large canopy-contributing trees; therefore, percent canopy cover has decreased. But, many of the lost trees were non-native, in decline, or generally weak-wooded; therefore, the overall net effect on the urban forest was positive. Also, due to limited manpower, the Urban Forestry Management Procedures were not fully implemented.

Prior to the above-mentioned tree losses, species and age diversity of Tinker AFB urban forest was very good. *Santamour's Species Diversity Model* and *Richard's Primary Age Diversity Model* will be reapplied periodically (same cycle as Metric 1) to determine current status of these parameters and their implications on the overall health of Tinker's urban forest.

Native Plant Landscaping

To reduce maintenance needs such as irrigation, fertilization, and pesticide use, Tinker AFB requires the use of native plant materials on most landscaping projects. This is in compliance with Presidential Memorandum, *"Environmentally and Economically Beneficial Practices on Federal Landscaped Grounds*,"

April 26, 1994, which states that where cost effective and to the maximum extent practicable, all plants used for landscaping on federal land shall be native (varieties/ subspecies and cultivars of native species are acceptable) to the local region. For Tinker AFB, local region is defined as:

- Central Great Plains ecoregion (mixed-grass prairie) with some eastern fringe areas in the Crosstimbers ecoregion (US EPA, 2005).
- Prairie and Great Plains Region as described in *An Annotated List of the Ferns, Fern Allies, Gymnosperms and Flowering Plants of Oklahoma* (Taylor and Taylor, 1994).

Native plants approved for planting on Tinker AFB are listed in Appendix E (Native Plant Landscaping Material List). See Green Infrastructure Plan (Tab 1) for additional regulatory guidance on landscaping with native plants.

Other Vegetation Management

For additional information on Tinker AFB vegetation management, refer to Section 7.11 (Integrated Pest Management Program), Appendix E (Native Landscaping Material List), Appendix F (Mitigation Action Tracker), Appendix G (Urban Forestry Management Procedures), Tab 1 (Green Infrastructure Plan), Tab 2 (Golf Course Environmental Management Plan), and Tab 3 (Wildland Fire Management Plan).

7.8 Forest Management

Applicability Statement

This section applies to AF installations that maintain forested land on AF property. This section **IS NOT** applicable to Tinker AFB. However, Tinker AFB does manage the urban forest (see Section 7.7 and Appendix G, Urban Forestry Management Procedures)

Program Overview/Current Management Practices

N/A

7.9 Wildland Fire Management

Applicability Statement

This section applies to AF installations with unimproved lands that present a wildfire hazard and/or installations that utilize prescribed burns as a land management tool. This section **IS** applicable to Tinker AFB.

Program Overview/Current Management Practices

For information regarding installation wildland fire management and prescribed burning, refer to the Wildland Fire Management Plan (Tab 3).

7.10 Agricultural Outleasing

Applicability Statement

This section applies to AF installations that lease eligible AF land for agricultural purposes. This section **IS** applicable to this Tinker AFB.

Program Overview/Current Management Practices

Much of Tinker AFB land is suitable for agriculture. Approximately 22 acres of pasture were maintained for grazing purposes at the Tinker AFB riding stables until the 1990s when the acreage was reduced to about 15 acres to provide a site for new dormitories. Following the 1999 F-5 tornado that destroyed the riding stables and killed several horses, the pastures were converted to a softball and running track complex.

Haying was accomplished on the Tinker AFB airfield in the early to mid-1980s but was reportedly discontinued due to conflicts with the flying mission (e.g., haying interfering with flying operations, and haying becoming difficult and unprofitable due to flying operations).

In 2009, approximately 115 acres of grassland around Building 9001 were outleased for haying. This was reduced to 110 acres in 2015 and to 92 acres in 2017 due to land development. In Dec 2017, the lease was terminated due to lessee compliance violations.

In 2011, due to grounds maintenance budget cuts, the grounds maintenance contractor (i.e., Trace) began to hay some areas in lieu of mowing. This was separate from the B-9001 haying lease and expanded the base haying acreage by approximately 190 acres. This was comprised of many relatively small, fragmented areas but also included some larger areas such as airfield clear zones. Special safety practices were required in the clear zones to ensure bird/wildlife aircraft strike hazards did not increase; however, Trace elected not to hay the clear zones. All haying by Trace was discontinued about 2013 and reverted to mowing.

In 2018, 114 acres around Building 9001 and on the CEIG campus were outleased for haying. In 2019, the lease was expanded to 141 acres by adding Landfill 6 and a field on the west side of the Navy campus.

Haying leases have been executed competitively through the Tinker AFB Civil Engineering (CE) Real Estate office. Currently, the lease is jointly managed by the Tinker AFB Real Estate and natural resources functions. Compliance inspections have been conducted annually by natural resources staff using a standardized compliance checklist. The areas have typically been hayed one time annually. This has been accomplished after 1 August of each year to ensure compliance with the Migratory Bird Treaty Act (i.e., no haying within the 1 Apr - 1 Aug bird breeding season). The hay is a mixture of mostly exotic grasses (predominantly Bermuda and Johnson grasses) and forbs with some native species.

7.11 Integrated Pest Management Program

Applicability Statement

This section applies to AF installations that perform pest management activities in support of natural resources management, e.g. flora and fauna invasive species, forest pests, household pests, etc. This section **IS** applicable to Tinker AFB.

Program Overview/Current Management Practices

Animals, including but not limited to insects, spiders, snakes, rodents, skunks, raccoons, bobcats, and feral cats/dogs that pose human health and safety hazards or that damage government property are controlled by Tinker AFB Pest Management personnel. Pest birds (to include BASH related issues) and most large animals such as deer, coyotes, and beaver are controlled by United States Department of Agriculture–Wildlife Services (USDA–WS) personnel who are officed with the Civil Engineering natural resources function. Improved and semi-improved grounds weed control, including but not limited to weeds in cracks of concrete/asphalt, graveled storage yards, planting beds, and turfgrass is accomplished by the grounds maintenance contractor or golf course personnel depending on location. Invasive weeds in natural

areas are typically controlled by contractors who specialize in natural area restoration; this is overseen by Tinker natural resources staff.

For more specific information on Tinker AFB integrated pest management, refer to Section 5 (Training), Section 6.2 (Reporting), Section 7.12 (Bird/Wildlife Strike Hazard), and Tab 5 (Integrated Pest Management Plan). Information on flora and fauna invasive species management is detailed below.

Invasive Species (Flora)

Executive Order 13112, Invasive Species, requires all federal agencies to prevent the introduction of invasive species, provide for their control, and minimize their economic, ecological, and human health impacts. Invasive species are defined as indigenous and non-indigenous plants, including their seeds, spores, or other biological material, that have a propensity to aggressively invade and/or displace native vegetation. These plants tend to have high reproductive rates, rapid establishment and dispersal, and are very adaptable. If not controlled, invasive plants can cause negative economic, ecological, military operational, and human health and safety impacts.

Five plant-related studies/surveys conducted on Tinker AFB [i.e., Vegetation Inventory of Tinker AFB, Oklahoma (Glenn, et al., 1993); Native Tallgrass Prairie Assessment/Management Plan (Johnson, et al., 1995); Non-Native/Invasive Plant Species in the Urban Greenway (Dorr & Pokorski, 2007); Tinker AFB Urban Tree Inventory (Dorr, et al., 2007); and Invasive Species Assessment, Tinker Air Force Base (Whitsitt, et al., 2011)] provide useful invasive species information. Plants identified in these studies/surveys were compared with plants listed in the Oklahoma Non-Native Invasive Plant Species (Oklahoma Invasive Plant Council, 2011) and Invasive Plants in Southern Forests (Miller, et al., 2010) publications. This indicated that 68 exotic/invasive plant species currently occur on Tinker AFB (see table, "Invasive Plant Species Known to Currently Exist on Tinker AFB."

Quantitative data were collected during the 2007 non-native/invasive plant survey of the Urban Greenway. Though this study was not conducted base-wide, it identified the predominate invasive woody species in the Urban Greenway to be lacebark elm, Siberian elm, Chinese privet, Japanese honeysuckle, Morrow's bush honeysuckle, and multiflora rose (Dorr & Pokorski, 2007).

Invasive Plant Species Known to Currently Exist on Tinker AFB

Common Name	Botanical Name	Common Name	Botanical Name
Trees		**Shrubs**	
Amur maple	*Acer ginnala*	Amur honeysuckle+	*Lonicera maackii*
Tree of heaven+	*Ailanthus altissima*	Morrow's honeysuckle+	*Lonicera morrowii*
Mimosa (Silktree)	*Albizia julibrissin*	Multiflora rose+	*Rosa multiflora*
Paper mulberry	*Broussonetia papyrifera*	**Vines**	
Russian olive	*Elaeagnus angustifolia*	Oriental bittersweet	*Celastrus orbiculatus*
Eastern redcedar*+	*Juniperus virginiana*	Ivyleaf morning-glory	*Ipomoea hederacea*
Panicled golden raintree**	*Koelreuteria paniculata*	Japanese honeysuckle+	*Lonicera japonica*
Chinese privet+	*Ligustrum sinense*	Kudzu	*Pueraria lobata*
White mulberry	*Morus alba*	**Forbs**	
Japanese black pine	*Pinus thunbergii*	Thymeleaf sandwort	*Arenaria serpyllifolia*
White poplar	*Populus alba*	Shepherd's purse	*Capsella bursa-pastoris*
Lombardy poplar	*Populus nigra*	Hoary cress	*Cardaria draba*
Callery pear+	*Pyrus calleryana*	Canada thistle	*Cirsium arvense*
Sawtooth oak	*Quercus acutissima*	Asiatic dayflower	*Commelina communis*
Lacebark elm+	*Ulmus parvifolia*	Sulphur cosmos	*Cosmos sulphureus*
Siberian elm+	*Ulmus pumila*	Queen Anne's lace	*Daucus carota*
		Deptford pink	*Dianthus armeria*
Grasses		Redstem stork's bill	*Erodium cicutarium*
Jointed goatgrass	*Aegilops cylindrica*	Flower-of-an-hour	*Hibiscus trionum*
Plains bluestem+	*Bothriochloa ischaemum*	Prickly lettuce	*Lactuca serriola*
Japanese brome+	*Bromus arvensis*	Henbit deadnettle	*Lamium amplexicaule*
Cheatgrass+	*Bromus tectorum*	Sericea lespedeza+	*Lespedeza cuneata*
Bermuda grass+	*Cynodon dactylon*	Black medick	*Medicago lupulina*
Yellow nutsedge	*Cyperus esculentus*	White sweet clover	*Melilotus alba*
Nutgrass	*Cyperus rotundus*	Yellow sweet clover	*Melilotus officinalis*
Barnyardgrass	*Echinochloa crus-galli*	Narrowleaf plantain	*Plantago lanceolata*
Indian goosegrass	*Eleusine indica*	Prostrate knotweed	*Polygonum aviculare*
Weeping lovegrass+	*Eragrostis curvula*	Sulphur cinquefoil+	*Potentilla recta*
Japanese stilt grass	*Microstegium vimineum*	Curly dock	*Rumex crispus*
Dallisgrass	*Paspalum dilatatum*	Bouncingbet	*Saponaria officinalis*
Annual bluegrass	*Poa annua*	Common dandelion	*Taraxacum officinale*
Bulbous bluegrass	*Poa bulbosa*	Yellow salsify	*Tragopogon dubius*
Tall fescue+	*Schedonorus phoenix*	White clover	*Trifolium repens*
Meadow fescue	*Schedonorus pratensis*	Common vetch	*Vicia sativa*
Green bristlegrass	*Setaria viridis*	Winter vetch	*Vicia villosa*
Johnson grass+	*Sorghum halapense*	Common periwinkle	*Vinca minor*
Bamboo spp.++	*Species unknown*		

+Plants have been observed on Tinker AFB to be very aggressive and cause ecological concern.

++Bamboo occurs in a dense, 0.5-acre stand in the northwest quadrant of Glenwood

*The eastern redcedar is not an exotic species; however, it can be very invasive if land is not properly managed and therefore is included here as a species requiring monitoring/control.

**The panicled golden raintree, a non-native tree on Tinker AFB, is not classified as an invasive species, yet natural resources personnel have witnessed invasive tendencies (i.e., highly reproductive; rapidly establishes/disperses) in this species in native grassland areas on Tinker AFB.

Tinker AFB Invasive Flora Species Characterizations

Problems associated with invasive species on Tinker AFB have been primarily ecological and human safety-related (i.e., redcedar fire hazard). The most notable known, ecologically disruptive invasives on Tinker AFB are sericea lespedeza, Johnson grass, Bermuda grass, tall fescue, Japanese brome, cheatgrass, plains bluestem, weeping lovegrass, lacebark elm, Siberian elm, Callery pear, Tree of heaven, panicled golden raintree, eastern redcedar, Chinese privet, Japanese honeysuckle, and Amur/Morrow bush honeysuckle.

Sericea lespedeza is a warm-season forb that has rapidly invaded remnant prairie areas in Reserves 1 and 3 of Tinker's Urban Greenway (refer to the Tab 1, Green Infrastructure Plan, for Greenway locations). A small colony has also been observed in the unimproved fringes of Soldier Creek. Control of this invasive has been conducted since 2006 by a combination of herbiciding and prescribed burning. Without this control in Reserve 3, much habitat for the Texas horned lizard would be lost, and extirpation of this lizard would likely occur over time.

Johnson grass is a very robust and stubborn warm-season perennial found base-wide and will out-compete or significantly degrade native grass stands if left unchecked. Herbicidal control of these species is ongoing within the Urban Greenway.

Bermuda grass is a warm-season perennial found at numerous locations base-wide. It has historically been the primary turfgrass on Tinker AFB and is very similar to Johnson grass in its invasive and persistence tendencies, but because of is prostrate growth habit it is less threatening to healthy native grass areas that are protected from mechanical disturbance. Herbicidal control of these species is ongoing within the Urban Greenway.

Tall fescue is a cool-season perennial found base-wide and is a threat to established native grass stands particularly in wet, shady, and disturbed areas. Primary control of this species has been along the southwest fringes (i.e., interface of firebreak and native grass remnant) of Reserve 3 in the Greenway.

Japanese brome and cheatgrass are cool-season annuals found in grassland and woodland areas base-wide, particularly in areas of disturbance. Control of this species has been accomplished within the Urban Greenway by mowing prior to brome seeding and by prescribed burning.

Plains bluestem is an aggressive warm-season perennial found primarily in Reserves 1 and 3 of the Urban Greenway but also occurs in lighter infestations base-wide (see figure, "Plains Bluestem Monoculture"). It will invade healthy native grassland areas upon minor disturbance. Control by spot and broadcast herbicide treatments are on-going within the referenced Reserves.

Weeping lovegrass has invaded a significant acreage in the northeast corner of Glenwood, but limited control has been initiated to date. A small infestation has also been observed and control initiated in the Urban Greenway immediately adjacent to the south of B-1049.

Lacebark and Siberian elms are the most aggressive exotic tree invaders on Tinker AFB, rapidly establishing in many unmowed areas in and around the Urban Greenway, golf course native grass areas, and in unimproved fringes of Soldier Creek. Cut-and-treat (i.e., herbicide) techniques have been used to eradicate hundreds of these trees in Reserve 1 of the Greenway. Additionally, about 5 acres of dense lacebark and Siberian elm woodland areas have been removed by mastication machines in the Greenway since 2011.

Plains Bluestem Monoculture: Plains bluestem located in Tinker AFB Urban Greenway significantly lowers biological diversity and ecosystem health.

Callery pear occurs Greenway-wide with greatest occurrence observed in Reserve 2 (North) and Reserve 3 of the Greenway. Control by cut-and-treat and prescribed burning has been accomplished in Reserve 3. Mastication has removed most pears in Reserve 2 (North).

Tree of heaven is an aggressive, rapidly growing and spreading tree. It has been identified only in Reserve 2 (South) of the Greenway and in Glenwood. Limited control has been initiated for this species.

Panicled golden raintree is a common ornamental in the region and has invaded a native grassland area on the golf course. The invasion was dense, but the spread of this species appears to restrict itself to areas immediately surrounding the parent plant, possibly due to raintree seeds being relatively large and less mobile. If left unchecked, however, this plant would become problematic in the long-term. Some cut-and-treat of this species has been accomplished, and scheduled prescribed burning is expected to subdue spread.

Eastern redcedar is an evergreen tree. Although it is native, it can be very invasive if not properly managed. These trees will severely degrade existing native grasslands and threaten to eliminate Oklahoma penstemon (a rare plant) colonies in grassland areas. Invasion also can result to the decline of other biota such as the Texas horned lizard. Redcedar populations in Glenwood could become so dense that land becomes unsuitable for military training, and the probability of catastrophic wildfires during dry periods increases significantly due to heightened fuel loads.

Redcedar control has been accomplished on Tinker AFB by mechanical removal (i.e., mowing, chain sawing, brush trimming, masticating) and prescribed burning. Since 1999, approximately 3980 redcedars have been mechanically removed with chainsaws and brush trimmers, with hundreds of seedling/sapling redcedars eradicated during prescribed burns. Also, approximately 36.5 acres of cedars have been removed base-wide by mastication since 2012.

Chinese privet is an evergreen/semi-deciduous shrub of woodland areas on Tinker AFB. Small-scale control has been accomplished by cut-and-treat methods in Reserve 1 of the Greenway.

Japanese honeysuckle occurs throughout the Urban Greenway and SE corner of Glenwood. No control has been initiated for this plant.

Amur/Morrow's bush honeysuckle occurs throughout the Urban Greenway. Aggressive control of bush honeysuckle has been initiated in Reserve 1 of the Greenway with 1500+ plants removed 2008-present.

Kudzu occurs in one isolated location in the southeast corner of CEIG.

Aquatic Plant Rules:

The Oklahoma Department of Wildlife Conservation has enacted statewide aquatic nuisance species restrictions. Specifically, Rule 800:20-4-2, Movement of Aquatic Plants, states: "No person may transport aquatic plants between waters of this state. Persons leaving any water of this state must remove all aquatic plants from boat, trailer, or any other gear capable of holding aquatic plants immediately after leaving the body of water from which the plants originated."

Flora (Invasive Species)

Status ■

Trend ⬇

Metric: Although metrics have not been established for this resource area, based on limited field surveys and incidental observations, the status and trend of Tinker AFB native vegetation communities as related to invasive species is currently rated as POOR and DOWNWARD, respectively. Although pockets of progress have been made, invasive plant species are present and spreading in many other natural areas on Tinker AFB. The degree and rate of invasion are unknown. However, this is forecasted to be reversed within the next decade for the following reasons:

- Base-wide Invasive Species Assessment to identify infestations has been completed and will foster a targeted and prioritized control strategy;
- Ongoing and currently programmed projects for eradication/control of invasives and conversion to native prairies/woodlands on golf course and Urban Greenway system; and
- Base-wide expansion of annual prescribed burning

Invasive Species (Fauna)

There are sixteen non-native wildlife species that occur, or have occurred, on Tinker AFB (see table, "Non-native Species Occurring on Tinker AFB"). These species have been documented as a result of faunal inventories (see Appendix D, "Fauna List"). Some of these species (i.e., trout) have been stocked and managed for sport fisheries and only inhabit Tinker AFB when water temperatures are cold enough for survival. Triploid grass carp (*Ctenopharyngodon idella*) also have been periodically stocked in base ponds to control nuisance aquatic plant growth. Grass carp have been stocked only in triploid sterile form in accordance with Oklahoma Administrative Code (OAC) 800:20-1-2. This is the only species known to occur on Tinker AFB that is listed as a "Restricted Aquatic Nuisance Species" under OAC 800. Of these 16 non-native wildlife species, the birds, domestic cat, common carp, basket clams, and red imported fire ants are considered invasive due to rapid spread and resultant ecological harm.

Four non-native avian species have been documented on Tinker AFB. The Eurasian collared dove (*Streptopelia decaocto*) was originally introduced in the U.S. from Eurasia likely through the Bahamas and spread to southern Florida and portions of the midwest to the California coast (NatureServe, 2011). While clearly invasive in the U.S., it is unclear at this time what negative impact this species may have. Also from Europe, the European starling (*Sturnus vulgaris*) was introduced to the U.S. in 1890 in New York City, and has spread and currently breeds across all of North America. The greatest concern for Tinker AFB is this invasive species flocking behavior in the fall as it stages for migration. This represents a significant threat to aircraft operations at Tinker AFB, which require implementation of flight restrictions during the fall time period (see BASH Plan 91-212). These birds also can usurp the nests of native cavity-nesting birds such as bluebirds and woodpeckers. The Rock dove (*Columbia livia*) and European house sparrow (*Passer domesticus*) have also been widely distributed across North America and represent threats primarily to aviation and competition with native species. All of these birds receive no protection under the Migratory Bird Treaty Act and are routinely controlled as nuisance species.

Feral dogs (*Canis domesticus*), and especially cats (*Felis catus*), have been documented worldwide as causing harm to native wildlife populations; however, no specific incidents have been documented on Tinker AFB. Humane trapping and removal of feral cats and dogs is performed by Tinker AFB Pest Management Shop and USDA Wildlife Services. This is required under DODI 4715.03, Natural Resources Conservation Program, which requires the DOD to control feral animals on military installations as needed.

Common carp (*Cyprinus carpio*), occasionally found in Tinker AFB streams, are often regarded as a nuisance species, but not listed in OAC 800 (see figure, "Invasive Species Common Carp"). This is due to its undesirable effects on water bodies such as increasing turbidity and elimination of vegetation and aquatic habitat. Many other aquatic species such as the goldfish and common carp have become naturalized and often hybridize across large portions of the U.S. (Fuller et. al., 1999). However, for the Goldfish, much of its established range is restricted to portions of certain drainages. Some areas may represent repeated escapes or releases rather than established populations (Fuller et.al., 1999).

Widespread across the U.S., the Asian basket clam (*Corbicula fluminea*) is also found in Tinker AFB streams and ponds. Although not regulated under section 800 and despite little research being done to determine the extent of this invasive's impacts, it is known to clog intakes of dams and likely compete with highly vulnerable native bi-valves. Since boating is not permitted on Tinker AFB ponds, concerns with other listed aquatic species such as the zebra mussel (*Dreissena polymorpha*) or quagga mussel (*Dreissena bugensis*) is not an issue on Tinker AFB.

Another invasive invertebrate species is the red imported fire ant (RIFA), (*Solenopsis invicta*). It has spread across much of the southern U.S. and has been documented in all of Oklahoma, with the exception of the

panhandle. Historically, the RIFA had been found just off Tinker AFB, associated with electrical transformers and lines. In 2016, it was discovered in several locations on base where it was believed to have been introduced through sod and landscape plantings. Broadcast treatments with granular insecticides and drenches are routinely accomplished where needed (see figure, "Red Imported Fire Ant Locations").

Non-native Species Recorded on Tinker AFB

Non-native Species Recorded on Tinker AFB	
Eurasian Collared-Dove	*Streptopelia decaocto*
Rock dove	*Columba livia*
European starling	*Sturnus vulgaris*
House sparrow	*Passer domesticus*
Domestic cat	*Felis catus*
Domestic dog	*Canis domesticus*
Mediterranean gecko E	*Hemidactylus turcicus*
Brook trout S	*Salvelinus fontenalis*
Brown trout S	*Salmo trutta*
Rainbow trout S	*Oncorhynchus mykiss*
Common carp	*Cyprinus carpio*
Fathead minnow (Rosy-red)	*Pimephales promelas 'Golden Strain'*
Goldfish D	*Carassius auratus*
Grass carp S *(Triploid)	*Ctenopharyngodon idella*
Basket clams v	*Corbicula fluminea*
Red imported fire ant	*Solenopsis invicta*

* Regulated under section OAC 800
S Species stocked for sport fish management

Invasive Common Carp:
Common carp seined in Crutcho Creek
often reach large sizes even in small streams.

Some non-native wildlife, like the gold fish, Rosy-red minnow, and Turkish house gecko, are not necessarily considered invasive. A portion of Kuhlman Creek flowing through Tinker's golf course was recently found to contain large numbers of goldfish (*Carassius auratus*), likely due to an aquarium release. Earlier stream sampling had not shown goldfish to be present (Moody & Lemmons, 2005). They appeared to be confined to the stream's uppermost section, likely due to lack of predators. These goldfish were easily eliminated through the introduction of adult largemouth bass.

The Rosy-red minnow (*Pimephales promelas* 'Golden Strain') has also been documented in Tinker AFB stream surveys. While not completely a non-native species, it is a species strain derived from the fathead minnow breed of the aquarium industry and was introduced through bait or aquarium releases. It does compete with native fish populations, but has not been documented as doing significant ecological harm.

The Turkish house gecko (*Hemidactylus turcicus turcicus*), formerly called the Mediterranean gecko, has spread worldwide and can be found across most of the southern United States. It is known for its tendency to inhabit human dwellings. This, along with the lack of predators in introduced areas, has contributed to its proliferation (Franklin, 1997). It has been occasionally found on Tinker AFB, particularly in facilities such as Building 1 and former Building 460. It is likely these hitchhikers found their way here on military cargo aircraft from the Mediterranean region. They have not been observed in Tinker's native habitat and are believed to require climate controlled building environments to survive Oklahoma winters.

Red Imported Fire Ant Locations: RIFAs have been identified at many locations on and adjacent to TAFB.

Fauna (Invasive Species)

Status Unknown

Trend Unknown

Metric: No metric has been established for invasive fauna species, and status and trend is unknown.

7.12 Bird/Wildlife Aircraft Strike Hazard (BASH)

Applicability Statement

This section applies to AF installations that have a flying mission and the potential for bird/wildlife aircraft strike hazards. This section **IS** applicable to Tinker AFB.

Program Overview/Current Management Practices

Tinker AFB manages wildlife, particularly birds and larger mammals, consistent with the Air Force's Bird/Wildlife Aircraft Strike Hazard (BASH) Program. Tinker's flight safety office is primarily responsible for BASH program management. The Civil Engineering (CE) natural resources function serves as liaison to state and federal conservation agencies and advisor to the BASH committee which is chaired by the 72 ABW Installation Commander. CE natural resources staff maintain a migratory bird depredation permit issued by the USFWS to conduct intentional takes of migratory birds. The United States Department of Agriculture–Wildlife Services (USDA-WS) and Base Operations staff serve as sub-permittees.

Wildlife damage control is accomplished by USDA-WS and Civil Engineering Pest Management shop in coordination with Tinker's natural resources program. Wildlife Services entered into their first cooperative agreement with Tinker AFB for integrated wildlife damage management including avian species control in 2001. Since that time, the agreement has evolved into a recurring five-year cooperative agreement for integrated wildlife damage management. The most recent agreement has expanded to include increased monitoring of wildlife and development of metrics to improve focus and management of damage control. A full-time wildlife biologist and full-time wildlife technician are provided through the agreement. They are officed with and coordinate closely with Tinker AFB natural resources staff.

Since Tinker AFB is highly urbanized, human-wildlife conflicts are not uncommon. Primary wildlife species which pose BASH concerns include beaver, coyotes, Canada geese, egrets, gulls, rock doves, European starlings, and occasionally deer. Beaver are found base-wide and are managed as important parts of Tinker's aquatic systems. They typically are not removed unless they disable creek spill gates, cause flooding issues, or their ponded areas attract waterfowl or wading birds near the airfield. Coyotes frequent the airfield and have been struck by aircraft; therefore, they are actively managed to limit their numbers on the airfield. Geese have nested on Tinker AFB in the past and if not regularly hazed will populate to numbers which pose aircraft safety concerns. Gulls frequent the airfield during spring and fall migrations particularly after precipitation events when forage is found on runways (see figure, "Gulls on Tarmac"). Egrets and herons have historically established rookeries (i.e., nesting locations) near Tinker AFB. Hundreds of birds migrated at low altitude across the base, particularly during the morning and evening. Egrets have been struck by aircraft in Tinker's flight pattern; therefore, active management for these species and their habitat on and off-base is conducted. Rock doves and European starlings inhabit many buildings and other structures and are controlled to reduce BASH and potential health hazards and corrosive damage to aircraft

caused by the birds' excreta. Specific information about species control is addressed in Tab 4 (Bird-Aircraft Strike Hazard Plan—Tinker AFB Plan 91-212) and Animal Damage Management Cooperative Agreement and Work Plans (see Appendix H, "Natural Resources Cooperative Agreements/Memorandums").

Gulls on Tarmac: Ring-billed and Franklin's gulls are typical visitors to the airfield following rain events during spring and fall migration seasons.

Air Force and Tinker AFB policy is to employ non-lethal control methods such as hazing, trapping, relocation, early nest removal, and other techniques to control wildlife. However, at times, lethal control is necessary. Lethal means are used with discretion, typically when persistent wildlife species are posing significant health, safety, or environmental damage concerns. For example, lethal control is used for coyotes on the airfield, beaver, and for small numbers of gulls to reinforce pyrotechnic hazing of larger flocks. Lethal methods are also frequently required for resident geese.

Several metrics for avian bird control and bird aircraft strikes have been developed in conjunction with the study "Inventory of Avian Species on Tinker AFB" (St. Germain, 2010). They include relative abundance (ra), strike numbers, and strike probability for the airfield. The top eleven bird threats have been consolidated into a table where they were ranked by these metrics and categorized by size and behavior (see table, "Top Eleven Bird Threats at Tinker AFB"). Birds were divided into large and small categories since large birds pose more dangerous strike hazards than small birds. In addition, birds that exhibit flocking behaviors were more likely to result in multiple strikes and ingestion into engines. To further evaluate strike threats, some birds were grouped by similar species, habits, and associations. For example, three different species of gulls were grouped together due to typical flocking and associations to one another. Another example is waterfowl, which was put into one group due to similar habits, such as flocking, use of similar habitats, and potential for strike behavior. Metric data were utilized from the St. Germain (2010) study to rank the birds. Eleven species/groups were identified in these rankings as having the highest threat potentials. The results provide a picture of the birds that present the greatest threat

potential under current management practices and abatement procedures of the Wildlife Damage Management (WDM) program. It should be noted that if these programs were not on-going and aggressive, the ranking would likely be much different. For example, resident geese numbers would be much higher due to favorable habitat such as the golf course and green space environments. Therefore, the list provides insight into current conditions for species and groups of birds for further focus of control efforts.

Top Eleven Bird Threats at Tinker AFB: The top eleven bird threats were compiled and ranked into metrics derived from data collected by the Virginia Tech bird survey.

TOP ELEVEN BIRD THREATS AT TINKER AFB

Bird Strike Probabilities and Relative Abundances Categorized by Size and Flocking Behavior and Ranked by Relative Abundance, Strike Probability and Actual Strike Numbers (metrics compiled in Aug 2011)

METRIC RANKS							
Probability	**Relative Abundance**	**No. Strikes**	**Group Name**	**Common /Scientific Name**	**No. Strikes** *	**Relative Abundance (ra)****	**% Probability by season ***
Large - Flocking Birds (>200g)							
3	1	1	Gulls	*Franklin gull (280g), Ring-billed gull (520g)*	30	0.775	*54 (spr)* *1 (w)*
-	10	6	Waterfowl	*American white pelican (7500g), Canada goose (4500g), Bufflehead (380g), Canvasback (1220g), Grebe, Gadwall (910g), Hooded merganser (620g), Scaup, Mallard (1100g), Ring-necked, Coot, Blue-winged teal (380g)*	6	0.000	ND
Small - Flocking Birds (<200g)							
5	3	6	Black birds	*European starling (82g)*	6	0.512	1 (spr) 3 (s) 17 (f) 1 (w)
7	5	6	Swallows	*Barn swallow (19g)*	6	0.20410	7 (spr) 10 (s)
-	-	3	Goat suckers	*Common night hawk (62g)*	19	ND	ND
Large Birds (>200g)							
8	6	7	Raptors	*Turkey vulture (1830g), Swainson's hawk (855g), Mississippi kite (280g), Cooper's hawk (450g),Red-tailed hawk (1080g), Red-shouldered hawk (630g), Long-eared owl (260g)*	3	0.164	2 (spr) 2 (f) 4 (w)

9	9	8	Herons & Egrets	*Great blue heron (2400g), Green heron (210g), Little-blue heron (340g), Yellow-crowned night heron (690g), Great egret (870g), Cattle egret (340g)*	2	0.014	1 (spr)
Small Birds (<200g)							
1	4	2	E. Meadowlark	*Sturnella magna (90g)*	27	0.419	31% (spr) 72% (s) 47% (f)
2	2	7	Horned lark	*Eremophila alpestris (32g)*	3	0.727	1% (spr) 1% (s) 84% (w)
6	8	4	Killdeer	*Charadrius vociferous (95g)*	14	0.107	1% (spr) 5% (s) 14% (f)
4	7	5	Mourning dove	*Zenaida macroura (120g)*	11	0.119	1% (spr) 7% (s) 15% (f)

** Number of strikes taken from Tinker AFB BASH data sets 1991-2010. ** Relative abundance (ra) on the airfield (St.Germain, 2010).*
**** Strike probabilities were determined by relative strikes reported x relative abundances surveyed and then standardized (St.Germain, 2010).*
ND – *no data available, these entries were either due to the lack of field survey data or zero detection for species relative abundance which disallowed calculations for strike probability.*
Note – data was taken from the "Inventory of Avian Species on Tinker AFB" (St. Germain, 2010) and table, rankings and categorizations were determined by NR staff using experience within the WDM program and "The Sibley Guide to Birds" (Sibley, 2009).

To improve aircraft safety, Tinker AFB strives to comply with the Federal Aviation Administration's Advisory Circular 150/5200-33B, Hazardous Wildlife Attractants on or Near Airports. This circular provides guidance on certain land uses that cause movement of hazardous wildlife onto, into, or across an airport's approach or departure airspace or air operations area (AOA). The circular recommends specific separation distances from the AOA within which wildlife attractants, such as retention/detention ponds, wetlands, and certain types of agricultural and landscaping activities, should be avoided, eliminated, or mitigated.

Of particular concern on Tinker are numerous wetlands and retention/detention ponds that are within the separation distance (i.e., 10,000 feet) specified in the circular. Natural resources and USDA-WS staff have employed avoidance, elimination, and mitigation in managing these water bodies to promote a safe flying environment and sustain the ecological services and recreational benefits the water bodies provide. Since the mid-1990s, Tinker has eliminated or modified three water bodies which were attracting hazardous wildlife in close proximity of the airfield. A detention basin located adjacent to Landfill 5 (about 800 feet from Runway 18/36) was outfitted with concrete trickle channels to eliminate standing water. The 10-acre Glenwood wetland, located ½ mile north of Runway 18, was removed. The 5-acre Fire Pond located ½ mile west of Runway 18/36 was removed. Also, although not removed due to hazardous wildlife attraction, the Fuel Control Facility Wetland, located about ¾ mile east of Runway 18/36, was removed for

construction purposes. Mitigation required the wetland to be replaced, which was done 18 miles away from the base.

In addition to these actions, avoidance is being employed by not developing additional ponds or wetlands on base with the exception of relatively small detention ponds necessary to comply with storm water regulations and policies. For all other existing ponds and wetlands, mitigation is employed to maintain a safe flying environment. Specifically, USDA-WS staff monitor and manage hazardous wildlife populations associated with on- and off-base water bodies to ensure flight safety on and around Tinker AFB.

Fauna (Wildlife Damage Management)

Status

Trend Unknown

Metric: Three metrics are used for wildlife damage management: relative abundance, bird strikes, and strike probability (see table, "Top Eleven Bird Threats at Tinker AFB"). The following is a discussion of these metrics and predicted threats.

One of the highest observed threats appears to be gulls which have high strike probabilities Air Force-wide (i.e., 30% for Franklin's gulls in spring alone). On a worldwide basis, gulls present the largest threat to aircraft (Buckley and McCarthy, 1994; Burger, 1985). Gulls tend to have peak strike times between 0500 and 0900 hours with another peak around 1200 hours (Burger 1985). During base surveys (St. Germain, 2010), the greatest number of birds observed was migrating flocks of Franklin's gulls. During springtime, numerous large waves of these gulls were detected on several occasions passing over the Tinker AFB airspace. This species has also been observed foraging on taxiways and runways after rains. Findings of the St. Germain (2010) study showed a high probability of gull strikes at Tinker AFB, 54% as compared to 30% AF-wide.

While waterfowl activity during survey periods ranged from very low to non-detected, much of this is contributed to wildlife damage management activities and habitat modification efforts to control this species group. However, during spring and fall migration seasons, waterfowl and other water birds such as pelicans can represent significant threats, for example, when large flocks of pelicans stop over at Lake Stanley Draper.

A top threat in the small flocking bird category is blackbirds, primarily European starlings but also brown-headed cowbirds. Cowbirds occur in significant numbers as they stage in Oklahoma during fall migration. Probability of starling strikes was highest in fall at 17%. Relative abundance was also high at 0.512 with six strikes being recorded historically at Tinker AFB. Overall strike probability ranks 5th at Tinker AFB for this species. Another smaller flocking bird that is indicated on the threat list, but without data on abundance or probability, is goatsuckers. This group of birds is active at dawn, dusk, and night. The nighthawk is the most common species in this category. Survey data on nighthawks were not available due to their crepuscular and nocturnal behavior. The behavior of concern for this species is its attraction to airfield lights for foraging on flying insects. The number of strikes occurring with this species ranks it 3rd on the list in number of strikes on Tinker AFB.

Second highest number of strikes at Tinker AFB occurs with the eastern meadowlark. Fortunately, this species is also one of the lightest birds on the threat list with a weight of only 90 grams. It also ranked 4th in relative abundance at 0.419 and first in strike probability at 72%. It is most likely struck in summer followed

by spring and fall with probabilities of 31% and 47%, respectively. Eastern meadowlark control on the airfield is ongoing due to the birds' year-round presence on the airfield's grassland habitat. Another small bird leading in strike probability is the horned lark. This 32-gram bird had high relative abundance (0.727) and probability (84%) of being struck in winter. However, this bird only ranked 7th in number of strikes, with three being hit in a ten-year period.

Non-flocking large birds such as raptors, egrets, and herons that do not typically exhibit flocking behavior were found to be lower on the threat list. This is likely due to ongoing control and hazing measures in the airfield environment. They ranked lowest in relative abundance with raptors at 0.164 and egrets and herons at 0.014. Strike probability was also lowest with these species ranging from 1-4%. When raptors are trapped on the airfield, they are relocated away from Tinker AFB. In the spring, egret and heron activity is closely monitored around Tinker AFB and in the metro vicinity. When evidence of rookery establishment or colonial behavior is observed around Tinker AFB, the birds are first hazed. When possible, this is followed by habitat alteration when the birds migrate south for the winter. This typically prevents future rookery establishment. As evidenced by the St. Germain (2010) study, numbers of these birds have been held down, which had not always been the case. Several rookeries were historically located around Tinker AFB, and birds had established migration routes over the airfield. These routes and behaviors have been eliminated through persistent efforts of wildlife damage management at Tinker AFB.

7.13 Coastal Zone and Marine Resources Management

Applicability Statement

This section applies to AF installations that are located along coasts and/or within coastal management zones. This section **IS NOT** applicable to Tinker AFB.

Program Overview/Current Management Practices

N/A.

7.14 Cultural Resources Protection

Applicability Statement

This section applies to AF installations that have cultural resources that may be impacted by natural resource management activities. This section **IS** applicable to Tinker AFB.

Program Overview/Current Management Practices

For more information, refer to Tab 6 (Integrated Cultural Resources Management Plan).

7.15 Public Outreach

Applicability Statement

This section applies to all AF installations that maintain an INRMP. Tinker AFB **IS** required to implement this element.

Program Overview/Current Management Practices

Public outreach and education are integral to Tinker's natural resources program. Tinker's "People" goal, which emphasizes the human dimension of natural resources conservation, states, "Establish and sustain

community-wide (on and off base) pride and ownership in the installation's natural resources, focusing on a common vision and facilitating active participation from all who use, value, and influence natural resources." Working in coordination with base Public Affairs (72 ABW/PA), Tinker natural resources staff use a multidimensional approach to achieve this goal and promote understanding of natural resources stewardship objectives in support of the military mission. Targeted efforts include but are not limited to:

- Publications
  - Peer-reviewed articles in scientific journals (e.g., Herpetologica; Journal of Herpetology)
  - Natural Resources Annual Report
  - Magazine articles (e.g., Outdoor Oklahoma; Redbook; Air Force Magazine)
  - Newspaper articles ("Tinker Take Off" [weekly base paper]; The Oklahoman [daily regional newspaper]; USA Today)
- Televised/broadcast media
  - Statewide newscasts with local news stations
  - National Public Radio
  - Outdoor Oklahoma show
- Tours
  - Annual Employee Enhancement Program; Base Commanders; Air Force Junior Reserve Officers' Training Corps (JROTC); local municipality representatives; other DOD staff
- Presentations
  - National Military Fish and Wildlife Association; local municipalities; non-governmental organizations (NGOs); multi-county Master Gardeners; elementary/high school students
- Volunteerism
  - College, university, and high school student volunteers; work force volunteers; and conservation interns
- Internet
  - *i*Sportsman (i.e., customized, interactive, web-based service facilitates distribution of fishing, sensitive species, and herpetofauna information)
- Conservation exhibits and informational signage
  - Trailside interpretive exhibits
  - Trailhead signage
  - Permanent exhibit at Oklahoma City Zoo "Military and Wildlife"
- Conservation events
  - Oklahoma Wildlife Expo (Oklahoma's largest indoor and outdoor recreation exhibit)
  - Arbor Day
  - Fishing derbies/clinics
  - Earth Day
  - Oklahoma Department of Wildlife Conservation's Aquatic Resource Education Program (AREP)
  - Endangered Species Day at the Zoo
- Conservation brochures/posters

7.16 Geographic Information Systems (GIS)

Applicability Statement

This section applies to all AF installations that maintain an INRMP, since all geospatial information must be maintained within the AF GeoBase system. Tinker AFB **IS** required to implement this element.

Program Overview/Current Management Practices

The primary data management tool used by natural resources staff is a geographic information system (GIS), specifically ArcMap. Spatial and temporal data are currently being collected and managed for all natural resources areas including by not limited to:

- Flora
- Fauna
- Hydrology
- Soils
- Outdoor Recreation

This data is managed by the Center for Environmental Management of Military Lands (CEMML) in the Warner College of Natural Resources at Colorado State University. This AFCEC-funded position provides a specialist who manages all environmental GIS data for Tinker AFB, Vance AFB, Altus AFB, and Little Rock AFB. The specialist is officed on Tinker AFB. Other base GIS data such as facilities, utilities, and other gray infrastructure is managed by other contracted staff in the Tinker Civil Engineering Directorate.

8.0 MANAGEMENT GOALS AND OBJECTIVES

The installation establishes a natural resources mission and vision statement. The mission is a galvanizing statement of purpose. The vision is the program's desired future. Long term, expansive goals and supporting objectives further organize and focus the program's efforts to manage and protect natural resources while supporting the military mission. Objectives indicate a management initiative or strategy for specific long or medium range outcomes and are supported by projects, activities, and tasks. Projects, activities, and tasks are specific actions that can be accomplished within a single year and appear in the Annual Work Plan (Section 10). Also, in cases where off-installation land uses may jeopardize AF missions, this section may list specific goals and objectives aimed at eliminating, reducing, or mitigating the effects of encroachment on military missions.

These natural resources management goals and objectives have been formulated by the preparers of the INRMP from an assessment of the natural resources, current condition of those resources, mission requirements, and management issues previously identified. The goals and objectives are displayed in the 'Installation Supplement' section below in a format that facilitates an integrated approach to natural resource management. By using this approach, measurable objectives can be used to assess the attainment of goals.

Installation Supplement – Management Goals and Objectives

The setting of objectives and dates to accomplish them by is a collaborative process involving Tinker AFB, the U.S. Fish and Wildlife Service, and the Oklahoma Department of Wildlife Conservation. A significant amount of time has been spent collaborating, preparing the first draft of the Plan, coordinating with the agencies involved, incorporating their comments, and incorporating comments from others within the Air Force.

Some of the objectives will be accomplished by the dates set, and others, due to unforeseen circumstances, will not. Any objectives that have not been accomplished during the current fiscal year typically will be

carried forward for planning purposes into the next fiscal year. The Annual Work Plan (Section 10) for the next year is then revised to set new dates, including objectives not met during the previous year.

Mission:

Strengthen our warfighter and surrounding community by building a healthy, native, urban ecosystem.

Vision:

The following is a description of the *desired future* of Tinker's urban ecosystem and its connection to the military mission:

The military, their families, and local community are stronger as a result of the quality of life provided by Tinker's award-winning natural resources program.

This action-oriented, self-sustaining program has high on- and off-base community involvement through active stakeholder participation, volunteerism, partnerships, and other collaborative efforts. A model for industrial complexes, it thrives because the local community has taken pride and ownership in their surrounding natural environment. From senior-level management to entry-level staff, and from contractors to visitors, commitment to sound environmental stewardship is strong.

Balance between gray infrastructure (built environment) and green infrastructure (natural environment) is the hallmark of the program and ensures a quality environment which fully supports and sustains military operational needs and expeditionary combat capability. The green infrastructure has expanded to form a base-wide network making for a greener, more vibrant, and livable community. Native fish and wildlife populations are healthy and productive. Tinker AFB ponds, creeks, and wetlands are clear and clean. From the main entrance gates to the heart of the industrial complex, Tinker's image is outstanding! Intensely developed industrial areas have been transformed by oases of healthy, low-maintenance, native trees, shrubs, tall grasses, and wildflowers. These natural additions attractively compliment manicured grounds and display the area's proud prairie heritage.

Natural resources-related outdoor recreation opportunities are unmatched for an industrial military installation and greatly contribute to the health and wellness of the workforce. Miles of high-quality greenway trails take pedestrians, joggers, cyclists, and rollerbladers to any place on Tinker AFB and have evolved into a system for alternative transportation. Families can safely view an abundance of urban wildlife year-round. One can relax and readily catch fish at one of Tinker's many tree-lined ponds, and trophy-sized bass are not uncommon at Prairie and Primrose Ponds.

New media initiatives have greatly enhanced program communication, education, and awareness; program identity and public trust are high. Foundational office and field process improvements have transformed the program into a highly effective and efficient operation – one whose stability and momentum carry it smoothly through frequent Tinker AFB leadership and other key personnel transitions. New natural resources storage/maintenance facility has greatly enhanced field project organization and productivity.

The program is fully funded and staffed with well-paid, expert, managerial, technical, and field personnel in all major resource areas. Natural resources staff have become valued team members by putting customer needs at the forefront of the program – customer satisfaction is at an all-time high.

The bottom line: As an integral part of Team Tinker, the natural resources program has served as a catalyst for vast improvements to Tinker's natural systems resulting in a healthy and sustainable built environment that supports military readiness and strengthens community health and wellbeing.

Long-Range Goals:

Flora:
Effectively and efficiently develop and manage Tinker's natural and urban landscape to provide a safe, attractive, functional, low maintenance, and ecologically sound environment in character with the local ecoregion to support mission completion and provide a sustainable living and working environment.

Fauna:
Establish a healthy and sustainable native fish and wildlife community that enhances warfighter quality of life and reduces human-wildlife conflicts.

Hydrology:
Using a watershed management approach, provide for water conservation, flood control, and high water quality.

Soil:
Protect, restore, and wisely use our soil resources.

People:
Establish and sustain community-wide (on and off base) pride and ownership in the installation's natural resources, focusing on a common vision and facilitating active participation from all who use, value, and influence natural resources.

Program Management:
Manage the natural resources program to promote an effective, efficient, economical, and customer-oriented public service.

Flora Implementation Strategy

GOAL 1: Effectively and efficiently develop and manage Tinker's natural and urban landscape to provide a safe, attractive, functional, low maintenance, and ecologically sound environment in character with the local ecoregion to support mission completion and provide a sustainable living and working environment.

Urban Forestry

Objective 1: By 2023, improve environmental quality by increasing base urban forest percent canopy cover towards an overall canopy coverage of 25% [9% for industrial areas; 18% for commercial areas; and 35% for residential areas (including golf course)] and move towards a base-wide native to non-native tree ratio of 100:0.

Objective 2: By 2023, promote urban forestry awareness and a culture of effective and efficient and ecologically sound urban forestry protection and management practices on base in accordance with the Tinker AFB Urban Forestry Management Procedures (Appendix G).

Invasive Species (Flora)

Objective 1: By 2023, in accordance with Executive Order 13112, *Invasive Species*, prevent the introduction of invasive plant species, provide control, and minimize their negative economic, ecological, military operational, and human health impacts on Tinker Air Force Base [refer to Tab 1 (Green Infrastructure Plan) for scheduled invasive species activities].

Sensitive Species (Flora)

Objective 1: By 2023, move towards stabilizing and enhancing existing Oklahoma penstemon populations to ensure penstemon population sustainability and land-use flexibility for military activities.

General (Flora)

Objective 1: By 2023, update TAFB Vegetation Communities Map to reflect present status.

Green Infrastructure

Objective 1: By 2023, continue to promote on- and off-base awareness of green infrastructure (GI) plan benefits and requirements and institutionalize conservation planning principles and philosophies in all applicable base projects.

Objective 2: Through 2023, continue to restore and maintain Tinker's green infrastructure to improve habitat structure/health for species at risk (SAR), reduce base mowing requirements, increase and sustain free ecological services provided by the network, promote wildland fire safety, and enhance aesthetics (including required mowed spaces within the green infrastructure network).

Golf Course Management

Objective 1 (Challenge 1: Installation Compatibility Use Zone): To meet clear zone requirements, demolish existing clubhouse, and remodel B-6001 as the new clubhouse, which is outside the clear zone. (This objective has been established for general planning purposes consistent with the Installation Development Plan; no completion date is set due to uncertainty of funding).

Objective 1 (Challenge 2: Floodplains/Wetlands): By 2023, and following completion of Challenge 7 (Objectives 2 & 3), improve floodplain and adjacent habitat functions by initiating conversion of turf grass areas to native grasses. ***[Mgt, Habitat (WWYKA53206119 and out-years)]***

Objective 1 (Challenge 3: Water quality; Groundwater Management Unit; Installation Restoration Program Sites): By 2023, improve water quality by reducing pesticide and fertilizer inputs to waterways.

Objective 1 (Challenge 5: Oklahoma Species of Concern; Migratory Birds; Bird/Wildlife Aircraft Strike Hazard): Through 2023, maintain golf course diurnal raptor nesting at zero and minimize diurnal raptor foraging to ensure a safe aircraft flying environment northwest of Runway 13-31.

Objective 1 (Challenge 7: Vegetation Management): Through 2023, as funding permits support Tinker's Urban Forestry Objective 1 which states, *"By 2023, improve environmental quality by increasing base urban forest percent canopy cover towards and overall canopy coverage of 25%; 9% for industrial areas; 18% for commercial areas; and 35% for residential areas (including golf course) and move towards a base-wide native to non-native tree ratio of 100:0."*

Vegetation Management

Objective 1: By 2023, lower grounds maintenance by reducing/eliminating select maintenance activities on improved, semi-improved, and unimproved grounds while maintaining attractiveness, functionality, safety, and ecological integrity.

Fauna Implementation Strategy

GOAL 2: Establish a healthy and sustainable native fish and wildlife community that enhances warfighter quality of life and reduces human-wildlife conflicts.

Wildlife

Objective 1: By 2030, increase and sustain urban indigenous fish and wildlife species richness and abundance on Tinker AFB, except in the airfield environment.

Objective 2: Through 2023, continue management of the Glenwood deer herd within the carrying capacity of the Glenwood area.

Fish

Objective 1: By 2023, continue improvement of warfighter quality of life by increasing fishing satisfaction through the development of a model urban fishing program.

Objective 2: By 2023, increase awareness and use of urban fishing program while maintaining healthy sustainable sport fish populations.

Objective 3: By 2023, continue management of base sports fisheries utilizing an ecosystem management approach while maximizing fishing opportunities, biodiversity and sustained yields of fish stocks.

Objective 4: By 2023, influence watershed management to restore and enhance stream habitat, stabilizing species richness and abundance to levels typical of Midwestern/Great Plains stream fish assemblages.

Invasive Species (Fauna)

Objective 1: Through 2023, in accordance with Executive Order 13112, *Invasive Species*, prevent the introduction of invasive fauna species, provide control, and minimize their negative economic, ecological, military operational, and human health impacts on Tinker Air Force Base.

Sensitive Species (Fauna)

Objective 1: By 2023 and in concert with the Installation Development Plan, provide more military land use options/flexibility and increase horned lizard population densities/distribution on Tinker AFB and/or adjacent off-base lands by establishing viable horned lizard management and translocation methodologies.

Objective 2: By 2030, excluding the airfield, increase native wildlife species richness and abundance on base and on lands adjoining the base, focusing on species of greatest conservation concern.

Animal Damage Control

Objective 1: By 2023, while maintaining a healthy and sustainable native fish and wildlife community and consistent with the Migratory Bird Treaty Act and other applicable laws and regulations, continue to reduce human-wildlife conflicts on Tinker AFB, with a focus on flight safety.

Hydrology Implementation Strategy

GOAL 3: Using a watershed management approach, provide for water conservation, flood control, and high water quality.

Floodplain Management

Refer to Green Infrastructure (GI) Plan (Tab 1) and Golf Course Environmental Management (GEM) Plan (Tab 2) for scheduled floodplain-related projects and activities.

Wetland Management

Objective 1: By 2023, enhance, rehabilitate, and sustain wetland functions and values in Tinker AFB wetland systems.

General (Hydrology)

Objective 1: By 2023, keep 100- and 500-year floodplain data current to ensure adequate support for mission project needs.

Soil Implementation Strategy

GOAL 4: Protect, restore, and wisely use our soil resources.

Objective 1: By 2023, keep base soil data current and soil resources protected and available to support mission project needs.

People Implementation Strategy

Goal 5: Establish and sustain community-wide (on- and off-base) pride and ownership in the installation's natural resources, focusing on a common vision and facilitating active participation from all who use, value, and influence natural resources.

Objective 1: Increase base-wide natural resources program awareness and a culture of effective and efficient natural resources stewardship.

Objective 2: By 2023, continue to encourage community natural resources pride/ownership and accelerate natural resources project and activity accomplishment by maintaining a strong and sustainable volunteer-based military and civilian labor force.

Program Management Implementation Strategy

GOAL 6: Manage the natural resources program to promote an effective, efficient, economical, and customer-oriented public service.

Objective 1: By Jul of each year, meet execution timelines to ensure natural resources program is moving toward and supporting Program Management goal.

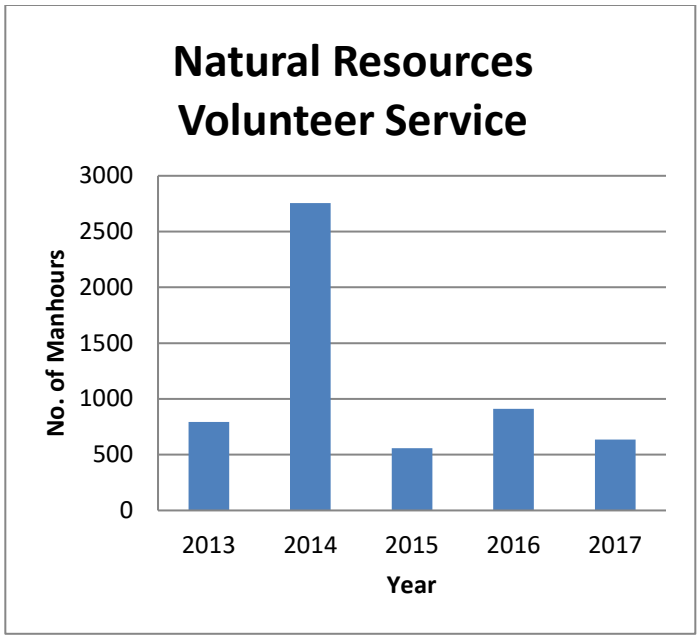
Objective 2: By 2023, apply 6S principles and institutionalize standardized business and organizational practices to improve and sustain high-level agility, compliance, and performance.

9.0 INRMP IMPLEMENTATION, UPDATE, AND REVISION PROCESS

9.1 Natural Resources Management Staffing and Implementation

Every Airmen (military, civilian, and contractor), including family members and visitors, is responsible for the stewardship of natural resources on and adjacent to Tinker Air Force Base. The lead base organization overseeing the implementation of this plan is the Civil Engineering Directorate, specifically the natural resources program office (72 ABW/CEIEC). This office has primary responsibility for ensuring execution of must-fund and other projects identified in this plan.

Permanent internal staffing required to implement the INRMP includes the natural resources program manager and a natural resources biologist. This is supplemented by internal civilian summer hires. External staffing includes a Geographic Information System (GIS) specialist, two USDA biologists, seasonal conservation interns, and other contract project support. Additionally, volunteer support is critical to INRMP implementation (see figure, "Natural Resources Volunteer Service). Volunteers have assisted with deer spotlight surveys, boardwalk renovation, invertebrate inventories, sensitive species research, and urban forestry projects such as developing tree planting plans, pruning trees, and transplanting trees. Volunteers include private individuals, Tinker AFB employees, scouting troops, area high school and college students, Oklahoma City Zoo staff, and others. Employing volunteers for conservation projects is authorized by DODI 1100.21, *Voluntary Services within DOD.*



The INRMP is initially considered approved and compliant with the Sikes Act when signed by the Tinker AFB commander, the Oklahoma Department of Wildlife Conservation (ODWC) director, and the United States Fish and Wildlife Service (USFWS), Region 2, director within the past five years. When the latest dated signatory expires (i.e., exceeds 5 years), the plan is non-compliant.

9.2 Monitoring INRMP Implementation

INRMP implementation is monitored through various metrics (see Status/Trend boxes in Sections 1.1, 7.0-7.16, and 9.1) and through the annual review process (see paragraph 9.3).

9.3 Annual INRMP Review and Update Requirements

To sustain approval, the INRMP is annually reviewed by the Civil Engineering natural resources function (72 ABW/CEIEC) and other internal base stakeholders in coordination with ODWC and the USFWS and ultimately approved/signed by the installation commander (see "TAFB INRMP Annual Review and Coordination Checklist" Note: Checklist dates are approximate, and execution may be completed earlier in the FY. Also, internal and external reviews may be accomplished concurrently.). The review aims to ensure the INRMP remains current as to operation and effect with respect to the Sikes Act. The annual review consists of conducting a natural resources assessment using, as a minimum, the following DOD-mandated focus areas to monitor program compliance with the Sikes Act:

INRMP project implementation

- Federally listed species and critical habitat
- Partnership effectiveness
- Fish and wildlife management and public use
- Team adequacy
- Ecosystem integrity
- INRMP impact on the installation mission

Findings of the annual review will be documented in the Annual INRMP Review Summary which includes:

- A summary of specific INRMP accomplishments since the last review
- A Work Plan for implementing the INRMP that includes the current year and at least four future fiscal years.
- A statement that sufficient numbers of qualified natural resources management personnel and resources are available to oversee implementation of projects and activities identified in the INRMP Work Plan.
- A summary of the required INRMP changes that will be incorporated into the document to keep it current in operation and effect for the management of installation natural resources; or a statement that significant changes to the installation mission or natural resources goals require a major INRMP revision (to include resigning by the Tinker AFB commander, ODWC director, and the USFWS Region 2 director).

The Annual INRMP Review Summary will be signed by the base commander and the collaborating agency representatives asserting concurrence with findings and that the natural resources management program is current as to operation and effect and compliant with the Sikes Act.

TAFB INRMP Annual Review & Coordination Checklist:

1 May 20__ – 15 Jun 20__: 72 ABW/CEIEC review and update INRMP by in-house conservation staff with agency input

- ☐ Complete Stage 2 self-inspection using Federal, State, and AF ECAMP inspection protocols and other internal checklists, as applicable.
- ☐ In main body of ***INRMP***, make changes and highlight in yellow for easy review by internal stakeholders and agencies.
- ☐ Adjust ***Annual Work Plan*** for upcoming FY and next two out-years
- ☐ Complete ***NR Program Annual Report*** documenting current fiscal year's accomplishments

16 Jun 20__ – 7 Jul 20__: Review by internal AF stakeholders (mandatory 21 calendar days)

- ☐ Send ***INRMP***, ***Annual Report***, and ***Annual Work Plan*** to internal TAFB stakeholders/reviewers through 72 ABW/XPX review process. Annual reviewers include:
    - AFSC/LG
    - OC-ALC
    - AWACS
    - Navy
    - 507th/513th
    - 38 CEIG
    - 72 ABW/JA
    - 72 ABW/PA

- 72 ABW/SE
- 72 MSG
- 72 FSS
- 72 OSS
- 72 SFS
- 72 ABW/CE
- AFCEC/CZO

8 Jul – 15 Jul 20__: Comment adjudication (internal stakeholders)

- ☐ 72 ABW/CEIEC adjudicate internal AF stakeholder comments

16 Jul 20__ – 13 Aug 20__: Review by agencies (USFWS & ODWC)

a. Send ***INRMP***, ***Annual Report*** and ***Annual Work Plan*** to USFWS and ODWC for review and comment.

14 Aug 20__ – 17 Aug 20__: Comment adjudication (agencies)

- ☐ 72 ABW/CEIEC adjudicate agency comments

18 Aug 20__ – 26 Aug 20__: Draft Annual Review Summary

- ☐ 72 ABW/CEIEC draft ***Annual Review Summary*** and obtain agency signatures on ***Agency Annual Coordination Form*** signifying operation and effect concurrence. The ***Annual Review Summary*** shall include:
  - **TAFB Natural Resources Annual Report** (summary of program accomplishments since last review)
  - **Annual Work Plan** (current and two out-years)
  - **Natural resources management personnel statement** (a statement that sufficient numbers of qualified natural resources personnel are available to oversee implementation of INRMP)
  - **Summary of incorporated updates from current INRMP annual review**

27 Aug 20__ – 31 Aug 20__: Prepare an Electronic Staff Summary Sheet (eSSS) for routing to 72 ABW/CC

- ☐ 72 ABW/CEIEC prepare eSSS (to include revised ***INRMP, Annual Report, Annual Work Plan, Annual Review Summary***, and agencies signed ***Annual Coordination Forms***) for routing of INRMP

1 Sep 20__ – 30 Sep 20__: Base Commander Certification/Signature

- ☐ Using 72 ABW/XPX coordination process, route eSSS through CE chain-of-command to 72 ABW to obtain wing commander's certification on ***Annual Review Certification***

Record, verifying the ***INRMP*** is valid and current, meeting the requirements of AFI-32-7064.

1 Oct 20__: Update Out-year Budget

- ☐ Upload updated ***INRMP, Annual Review Summary***, ***Agency Annual Coordination Forms (signed),*** and ***Annual Review Certification Record*** into eDASH
- ☐ Forward new projects identified in INRMP update to AFCEC for insertion into out-year budget

IMPORTANT DATES: INRMP must be revised and receive new agency signatures every 5 years. The current INRMPs term is Mar 2019 to Mar 2024 and expires on **15 Mar 2024**.

10.0 ANNUAL WORK PLANS

The INRMP Annual Work Plans are included in this section. Executing these projects, activities, and tasks are intended to meet the prescribed goals and objectives identified in Section 8 and move the program towards its vision.

Each year during natural resources planning sessions, select projects, activities, and tasks which support the program goals and objectives will be targeted to formulate this annual work plan. Some of the projects, activities, and tasks will be accomplished as scheduled; however, due to unforeseen circumstances, others may not. For planning purposes, any projects, activities, or tasks that have not been accomplished as scheduled will be carried forward into the next fiscal year.

These projects, activities, and tasks are listed by fiscal year, including the current year and four succeeding years. For each project, activity, and task a specific timeframe for implementation is provided (as applicable), as well as the appropriate funding source, and priority for implementation. The work plans provide all the necessary information for building a budget within the AF framework. Priorities are defined as follows:

High (H): The INRMP signatories assert that if the project is not funded the INRMP is not being implemented and the Air Force is non-compliant with the Sikes Act; or that it is specifically tied to an INRMP goal and objective and is part of a "Benefit of the Species" determination necessary for ESA Sec 4(a)(3)(B)(i) critical habitat exemption.

Medium (M): Project supports a specific INRMP goal and objective, and is deemed by INRMP signatories to be important for preventing non-compliance with a specific requirement within a natural resources law or by EO 13112 on Invasive Species. However, the INRMP signatories would not contend that the INRMP is not being implemented if not accomplished within programmed year due to other priorities.

Low (L): Project supports a specific INRMP goal and objective, enhances conservation resources or the integrity of the installation mission, and/or promotes long-term compliance with specific requirements within natural resources law, but is not directly tied to specific compliance within the proposed year of execution.

Annual Work Plan (FY 2020)

Flora Implementation Strategy

GOAL 1: Effectively and efficiently develop and manage Tinker's natural and urban landscape to provide a safe, attractive, functional, low maintenance, and ecologically sound environment in character with the local ecoregion to support mission completion and provide a sustainable living and working environment.

Urban Forestry

Objective 1: By 2023, improve environmental quality by increasing base urban forest percent canopy cover towards an overall canopy coverage of 25% [9% for industrial areas; 18% for commercial areas; and 35% for residential areas (including golf course)] and move towards a base-wide native to non-native tree ratio of 100:0.

Activity 1: By the end of each fiscal year, annually complete the Urban Forestry Management Checklist by dates specified [See Appendix G, Urban Forestry Management Procedures] **[L]**

Activity 2: By 2021, work with Balfour Beatty Communities to replant trees in base housing area. **[L]**

Objective 2: By 2023, promote urban forestry awareness and a culture of effective and efficient and ecologically sound urban forestry protection and management practices on base in accordance with the Tinker AFB Urban Forestry Management Procedures (Appendix G).

Activity 1: Annually, update/modify as appropriate base contract boiler plate sections (e.g., Sections 00 70 00 and 00 72 00), Architectural Compatibility Guide, grounds maintenance and exterior electric performance work statements, AAFES maintenance agreements, Military Family Housing maintenance standards, and other documents as necessary to reflect new requirements of Tinker's Urban Forestry Management Procedures. **[L]**

Task 1: Incorporate firewood program requirements in 00 72 00 and Grounds Maintenance Contract.

Activity 2: By 31 Mar, annually host base celebration of Arbor Week (last full week of March). **[L]**

Activity 3: By 15 Dec of each year, convene Urban Forestry Working Group for annual meeting. **[L]**

Invasive Species (Flora)

Objective 1: By 2023, in accordance with Executive Order 13112, *Invasive Species*, prevent the introduction of invasive plant species, provide control, and minimize their negative economic, ecological, military operational, and human health impacts on Tinker Air Force Base [refer to Tab 1 (Green Infrastructure Plan) for scheduled invasive species activities].

Activity 1: Continue invasive species control basewide with priority given to the Urban Greenway and lightly infested, high quality natural areas. **[M]**

Sensitive Species (Flora)

Objective 1: By 2023, move towards stabilizing and enhancing existing Oklahoma penstemon populations to ensure penstemon population sustainability and land-use flexibility for military activities.

> **Project 1:** Every other even year, and consistent with Tinker-specific monitoring methodologies established by Virginia Tech, census all on-base Oklahoma penstemon populations (densities; total acreage; number per colony; graphs for each population to track trends). **[L]**

General (Flora)

Objective 1: By 2023, update TAFB Vegetation Communities Map to reflect present status.

> **Activity:** By 2021, incorporate vegetation communities map into INRMP **[M]**

Green Infrastructure

Objective 1: By 2023, continue to promote on- and off-base awareness of green infrastructure (GI) plan benefits and requirements and institutionalize conservation planning principles and philosophies in all applicable base projects.*

Objective 2: Through 2023, continue to restore and maintain Tinker's green infrastructure to improve habitat structure/health for species at risk (SAR), reduce base mowing requirements, increase and sustain free ecological services provided by the network, promote wildland fire safety, and enhance aesthetics (including required mowed spaces within the green infrastructure network).

*Refer to Tinker AFB Green Infrastructure (GI) Plan (Tab 1) for projects, activities, and tasks.

Golf Course Management

Objective 1 (Challenge 1: Installation Compatibility Use Zone): To meet clear zone requirements, demolish existing clubhouse, and remodel B-6001 as the new clubhouse, which is outside the clear zone. (This objective has been established for general planning purposes consistent with the Installation Development Plan; no completion date is set due to uncertainty of funding).*

Objective 1 (Challenge 2: Floodplains/Wetlands): By 2023, and following completion of Challenge 7 (Objectives 2 & 3), improve floodplain and adjacent habitat functions by initiating conversion of turf grass areas to native grasses. ***[Mgt, Habitat, (WWYKA53206119 and out-years)]***

Objective 1 (Challenge 3: Water quality; Groundwater Management Unit; Installation Restoration Program Sites): By 2023, improve water quality by reducing pesticide and fertilizer inputs to waterways.

Objective 1 (Challenge 5: Oklahoma Species of Concern; Migratory Birds; Bird/Wildlife Aircraft Strike Hazard): Through 2023, maintain golf course diurnal raptor nesting at zero and minimize diurnal raptor foraging to ensure a safe aircraft flying environment northwest of Runway 13-31.

Objective 1 (Challenge 7: Vegetation Management): Through 2023, as funding permits support Tinker's Urban Forestry Objective 1 which states, *"By 2023, improve environmental quality by increasing base urban forest percent canopy cover towards and overall canopy coverage of 25%; 9% for industrial areas; 18% for commercial areas; and 35% for residential areas (including golf course) and move towards a base-wide native to non-native tree ratio of 100:0."*

*Refer to Tinker AFB Golf Course Environmental Management (GEM) Plan (Tab 2) for projects, activities, and tasks.

Vegetation Management

Objective 1: By 2023, lower grounds maintenance by reducing/eliminating select maintenance activities on improved, semi-improved, and unimproved grounds while maintaining attractiveness, functionality, safety, and ecological integrity.

Project 1: By 2020, continue base haying lease for the areas around Building 9001, CEIG campus, Navy campus, and Landfill 6 and expand to other areas where haying would reduce grounds maintenance costs. **[L]**

Task 1: Annually conduct pre- and post-haying lease inspections (Lease Compliance Inspection Checklist) to ensure compliance with lease agreement and land use regulations.

Fauna Implementation Strategy

GOAL 2: Establish a healthy and sustainable native fish and wildlife community that enhances warfighter quality of life and reduces human-wildlife conflicts.

Wildlife

Objective 1: By 2030, increase and sustain urban indigenous fish and wildlife species richness and abundance on Tinker AFB, except in the airfield environment.

Activity 1: Annually spot check stream fish diversity by sampling multiple locations and compare to baseline surveys in Fishes of Crutcho Creek Drainage Basin. **[L]**

Activity 2: Annually continue baseline invertebrate survey focusing on pollinators and develop entomological reference collection (volunteer). **[L]**

Objective 2: Through 2023, continue management of the Glenwood deer herd within the carrying capacity of the Glenwood area.

Activity 1: By Dec of each year, conduct fall spotlight surveys to estimate deer population and reproductive success (recurring). **[L]**

Activity 2: By Jan of each year, evaluate need for deer control, and as necessary implement measures to reduce numbers to maintain healthy deer densities at Glenwood and donate all harvested deer to ODWC's Hunter's Against Hunger Program, local zoos or similar programs. **[L]**

Fish

Objective 1: By 2023, continue improvement of warfighter quality of life by increasing fishing satisfaction through the development of a model urban fishing program.

Project 1: Continue a quality winter trout fishing program that has become well known on- and off-base through awareness events and has produced high catch rates with large trout frequently being caught. **[L]**

Task 1: By Nov of each year, kick off winter trout fishing season with an AREP event (recurring).

Task 2: Continue trout permit system to support stocking efforts on an annual basis (recurring).

Task 3: By Sep, coordinate purchase of trout to ensure availability of funds and provide trophy trout (4 pounds and greater).

Task 4: By Jan, coordinate with USFWS Neosho Missouri Hatchery the availability of trout, and if available make arrangements for pickup and hauling.

Project 2: By 2023, increase the number of trophy-sized fish (largemouth bass over 8 pounds and trout over 4 pounds) caught on Tinker AFB by 50%. **[L]**

Task 1: By 2020, move harvestable and trophy bass to Beaver and Primrose ponds.

Task 2: Annually evaluate fisheries survey results and adjust creel limits and other management recommendations to meet fishery expectations for each pond.

Project 3: By 2020, continue to enhance fishing-related infrastructure by improving access and adding amenities that enhance fishing experiences and promote low cost and convenience (i.e., trails, footbridges, docks, and signage). **[L]**

Task 1: By 2020, update and replace sign/graphics in Angler Information Station at Beaver Pond, ensuring UV protection of signage.

Task 2: By 2020, identify and post on tinker.isportsman.net areas open for fishing along Crutcho Creek.

Task 3: Maximize opportunities to utilize salvaged materials from constructions sites, urban tree work, and prairie restoration (e.g., boulders, logs, stumps, cedar trees) to enhance fishing access and habitat in Base ponds and streams.

Task 4: Conduct tree lifts/thinning and maintain mow paths for improved fishing access at Beaver Marsh Filter, and Crutcho Creek.

Objective 2: By 2022, increase awareness and use of urban fishing program while maintaining healthy sustainable sport fish populations.

Project 1: Annually maintain an on-line fishing permit purchasing system (USAF-contracted iSportsman). Maintenance of page to include: bulletin board, fishing guide, access information, fish identification, pond record fish, bragging board photo gallery, rules, regulations, and natural resource information pages (i.e., Tinker snakes and protected species) (recurring). **[M]**

Objective 3: By 2023, continue management of base sports fisheries utilizing an ecosystem management approach while maximizing fishing opportunities, biodiversity and sustained yields of fish stocks.

Activity 1: Capitalize on partnering activities as they become available particularly to facilitate stocking of fish for base ponds (e.g., ODWC catfish stocking). **[L]**

Activity 2: Annually survey base ponds, assess populations, and apply fisheries management recommendations (recurring). **[L]**

Activity 3: Annually facilitate and assist anglers in fishing derbies and clinics as opportunities arise. **[L]**

Activity 4: Conduct permit courtesy checks for anglers fishing base waters at least monthly during peak fishing seasons. **[L]**

Activity 5: Continue implementing strategy to control white crappie populations in base ponds. **[L]**

Activity 6: Continue to manage Beaver Pond as a "Kids & Family" fishing pond that produces quality, easy-to-catch sunfish. **[L]**

Task 1: Stock hybrid green sunfish in Beaver and Redbud Ponds (via ODWC promoting kids fishing programs).

Activity 7: Continue to manage Beaver Marsh Filter, Primrose, and Prairie Ponds for high quality trophy bass fishing. **[L]**

Objective 4: By 2023, influence watershed management to restore and enhance stream habitat, stabilizing species richness and abundance to levels typical of Midwestern/Great Plains stream fish assemblages.

Project 1: Restore floodplain vegetation in accordance with Green Infrastructure Plan (Tab 1). **[M]**

Task 1: Restore 50 acres of native vegetation within the 500-year floodplain (KC-46A mitigation).

Project 2: By 2023 continue implementing the strategy for base streams rehabilitation and conservation from the Matthews, Matthews-Marsh, and Moody (2010 & 2020) stream studies (Note: some cross-over into other sections of work plan). **[L]**

Project 3: By 2020, continue monitoring fish biodiversity at select stream sites utilizing methodology from the Matthews, Matthews-Marsh, and Moody (2010) stream studies. Evaluate results and make recommendations to the strategy for stream rehabilitation. ***[Mgt, Species, Native Fish Survey (WWYKA53206120)]*** **[L]**

Activity 1: Annually, enforce a riparian vegetation protection policy. **[M]**

Invasive Species (Fauna)

Objective 1: Through 2023, in accordance with Executive Order 13112, *Invasive Species*, prevent the introduction of invasive fauna species, provide control, and minimize their negative economic, ecological, military operational, and human health impacts on Tinker Air Force Base.

Activity 1: Annually incorporate/update monitoring/prevention requirements in base contract boiler plate sections (i.e., Sections 00 70 00 and 00 72 00), Architectural Compatibility Guide, grounds maintenance statements of work (e.g., Trace, AAFES), etc. to prevent the introduction and spread of Red Imported Fire Ants (RIFA) (*Solenopsis invicta*) and other invasive species on Tinker. **[M]**

Activity 2: Annually survey, monitor and treat areas on base infested with RIFAs. **[M]**

Sensitive Species (Fauna)

Objective 1: By 2023 and in concert with the Installation Development Plan, provide more military land use options/flexibility and increase horned lizard population densities/distribution on Tinker AFB and/or adjacent off-base lands by establishing viable horned lizard management and translocation methodologies.

Project 1: Continue comprehensive study for conservation and management of Texas horned lizards, particularly focusing on development of methodology for translocation ***[Mgt Species, WWYKA53206120 and out-years)]***. **[M]**

Task 1: Monitor density and population size of Texas horned lizards in Reserve 3 of the Urban Greenway.

Task 2: Assess the feasibility of Texas horned lizard hatchling translocation to establish or restore populations. ***[USACE-CERL ESTCP Transferring "Translocation Science" to Wildlife on DoD—3-year Grant]***

Task 3: Monitor stressors, survival, diet, and movements of hatchling and adult Texas horned lizards.

Task 4: Examine the effects of prairie restoration activities (herbicide, mowing, disking) and construction projects on Texas horned lizard population.

Task 5: Communicate results of study through publications and presentations at meetings.

Task 6: Further develop and implement existing joint partnership with USACE-CERL, University of Oklahoma and Oklahoma City Zoo to perform husbandry and translocation trials on hatchling horned lizards.

Objective 2: By 2030, excluding the airfield, increase native wildlife species richness and abundance on base and on lands adjoining the base, focusing on species of greatest conservation concern.

Activity 1: Continue to consult and advise Tinker's Readiness and Environmental Protection Integration (REPI) team to look at conservation easement establishment on nearby lands identified in the REPI Master Plan. **[M]**

Animal Damage Control

Objective 1: By 2023, while maintaining a healthy and sustainable native fish and wildlife community and consistent with the Migratory Bird Treaty Act and other applicable laws and regulations, continue to reduce human-wildlife conflicts on Tinker AFB, with a focus on flight safety.

Project 1: By 1 Sep, renew USDA Wildlife Services (WS) Memorandum of Understanding (MOU) and each fiscal year, renew ***USDA WS Financial/Work Plan (Agreement No. 06-7340-5525-IA)*** Renewal due by Sep 2021 **[H]**

Task 1: Each year, exercise Financial/Work Plan option and approve MIPR's for USDA WS animal damage control services for upcoming fiscal year.

Task 2: By Feb each year, reapply for annual Depredation Bird Permit.

Task 3: By Mar each year submit migratory bird depredation take report to the USFWS.

Task 4: Conduct migratory bird protection training for depredation sub-permittee holders.

Hydrology Implementation Strategy

GOAL 3: Using a watershed management approach, provide for water conservation, flood control, and high water quality.

Floodplain Management

Refer to Green Infrastructure (GI) Plan (Tab 1) and Golf Course Environmental Management (GEM) Plan (Tab 3) for scheduled floodplain-related projects and activities.

Wetland Management

Objective 1: By 2023, enhance, rehabilitate, and sustain wetlands functions and values in Tinker AFB wetland systems.

> **Project 1:** Every even year (starting in 2020), conduct on-the-ground site assessment of all base-affiliated wetlands (on- and off-base) and document findings. **[M]**
>
> **Project 3:** By 2020, mitigate loss of KC-46A wetlands via available on site opportunities (record actions taken in Appendix F, Mitigation Action Tracker). Refer to the Green Infrastructure (GI) Plan (Tab 1) and Golf Course Environmental Management (GEM) Plan (Tab 2) for additional scheduled wetland related projects and activities. **[H]**

General (Hydrology)

Objective 1: By 2023, keep 100- and 500-year floodplain data current to ensure adequate support for mission project needs.

> **Project 1:** As needed and in conjunction with projects potentially impacting floodplains, projects involving acquisition of new properties, and projects involving 100- and 500-year flood studies, revise base floodplain mapping accordingly. **[M]**

Soil Implementation Strategy

GOAL 4: Protect, restore, and wisely use our soil resources.

Objective 1: By 2023, keep base soil data current and soil resources protected and available to support mission project needs.

> **Activity 1:** Modify 00 70 00 and 00 72 00 contract boilerplates as appropriate to ensure that base topsoil and boulders are not hauled off from construction sites or disposed of off Tinker AFB property. **[L]**
>
> > **Task 1:** Conduct basewide (including airfield) evaluation to identify areas (e.g., holes; low, water-holding depressions; poor soil sites, etc.) where base topsoil could be reused.
> >
> > **Task 2:** Secure a soil stockpile site for base use.
>
> **Activity 2:** By 2020, update base soil mapping to reflect current state. **[L]**

People Implementation Strategy

Goal 5: Establish and sustain community-wide (on- and off-base) pride and ownership in the installation's natural resources, focusing on a common vision and facilitating active participation from all who use, value, and influence natural resources.

Objective 1: Increase base-wide natural resources program awareness and a culture of effective and efficient natural resources stewardship.

Activity 1: By 15 Nov of each year, publish Natural Resources Program Annual Report (for previous fiscal year) and distribute base-wide via email, base distribution, iSportsman, Civil Engineering web site and INRMP. **[M]**

Activity 2: By 2020, develop and distribute newcomers' natural resources packet. **[L]**

Activity 3: As 72 ABW senior leadership changes occur, conduct 2-hour natural resources program tour for new leadership (e.g., 72 ABW/CC, CV, DS, CCC, CE etc.) to maintain program momentum and promote program continuity during leadership transitions (Refer to Tab 1, Green Infrastructure Plan for additional program awareness activities) **[M]**

Activity 4: By 2020, increase natural resources program tours for a diverse cross-section of on- and off-base stakeholders to improve/broaden installation conservation awareness; encourage transparency and strengthened relationships with regulators and contractors; and encourage support unit staff who seldom get to see the on-the-ground fruit of their supporting efforts.

Activity 5: By 2020, working with 72 ABW Public Affairs, work with Oklahoma Gardening Show team to determine possibility of filming an episode on Tinker's Urban Greenway.

Objective 2: By 2020, continue to encourage community natural resources pride/ownership and accelerate natural resources project and activity accomplishment by maintaining a strong and sustainable volunteer-based military and civilian labor force.

Activity 1: Continue use of base personnel and local college and high school students aged 15 and older for conservation program volunteer service. **[L]**

Program Management Implementation Strategy

GOAL 6: Manage the natural resources program to promote an effective, efficient, economical, and customer-oriented public service.

Objective 1: By Jul of each year, meet execution timelines indicated below to ensure natural resources program is moving toward and supporting Program Management goal.

Project 1: By 1 Aug of each year, execute ***Equipment Purchase/Maintain, CN (WWYKA53200399 and out-years)***. **[H]**

Project 2: By 1 Aug of each year, execute ***Supplies, CN (WWYKA53200699 and out-years)***. **[H]**

Project 3: By 30 Sep of each year, execute ***Management Habitat (WWYKA53206119 and out-years).*** **[**Cooperative Agreement with University of Oklahoma via Great Plains Cooperative Ecosystem Study Unit (CESU) through the Fort Worth District of the Corps of Engineers—Agreement period: 24 Sep 2019 - 23 Sep 2020 (Base Year) + 4 option years (expires 23 Sep 2024, with last option year needing to be exercised by 23 Sep 2023).] **[H]**

Task 1: By Sep 2020, develop and implement natural resources technician checklist to facilitate timely completion of annually recurring natural resources projects, activities, and tasks.

Activity 1: By 30 Sep of each year, complete INRMP Annual Review and Coordination with internal stakeholders and local representatives of the USFWS and ODWC and document action according to tasks below. **[H]**

Task 1: Starting 1 May of each year, complete items identified in Tinker AFB INRMP Annual Review and Coordination Checklist (see Section 9).

Task 2: With Oklahoma Department of Wildlife Conservation (ODWC) and U.S. Fish and Wildlife Service (USFWS) participation, conduct internal natural resources self-assessment using the following DOD metrics (if required—refer to DODI 4715.03, Enclosure 5):

-INRMP project implementation

-Federally-listed species of critical habitat

-Partnership effectiveness

-Fish and wildlife management and public use

-Team adequacy

-Ecosystem integrity

-INRMP impact on the installation mission

Objective 2: By 2023, apply 6S principles and institutionalize standardized business and organizational practices to improve and sustain high-level agility, compliance, and performance.

Project 1: By 2020, initiate project to construct lean-to/pole barn on south side of B-809 for natural resources equipment and materials storage/staging. **[L]**

Project 2: By 2020, move natural resources equipment from Air Container 1 to Air Container 2 and demolish/recycle Air Container 1. **[L]**

Activity 1: Annually maintain natural resources program documents and utilize document management system. **[L]**

Task 1: Annually, organize and download photos into proper reorganized photo directories.

Task 2: Utilize Electronic Records Management System (ERMS) for storage and archiving natural resource documents.

Activity 2: By 2020, complete natural resources program plan to facilitate seamless staff transitions (e.g., during retirements or other separations) focusing on maintaining program momentum and vision trajectory. **[L]**

Task 1: By 2020, meet with CE management to develop personnel transition plan to ensure well qualified personnel are in place and have been adequately exposed to the program prior to key personnel separations.

Task 2: By 2020, develop natural resources program continuity book.

Activity 3: By 2020, organize office/equipment keys **[L]**

Task 1: Purchase key tags, make key spares, organize keys, and install new key boxes at Buildings 811 and 808.

Activity 4: Sort, update, and organize personal and reference desk/email files (including archive system; metadata/ERMS compliance) **[L]**

Activity 5: By 2020, develop maintenance schedules/record keeping for all natural resources equipment. **[L]**

Objective 3: By 2021, using Tinker AFB as a platform, host 3-day national workshop to train natural resources staff in how to build robust conservation programs that strengthen the Air Force mission.

Activity 1: By early 2021, coordinate with invited speakers

Activity 2: Perform B-811 upgrades in support of workshop

Task 1: Complete B-811 landscaping (self-help)

Task 2: Install front entrance canopy (self-help)

Task 3: Install heat and air unit stockade fence (self-help)

Task 4: Interior decorating with conservation theme (self-help)

Activity 3: Perform Urban Greenway upgrades in support of workshop

Task 1: Refurbish wildlife observation blind (self-help)

Task 2: Repair split-rail fencing Greenway-wide

Task 3: Design and install new interpretive panels, entrance signs, and angler information station signs

Task 4: Install trash can anchor system

11.0 REFERENCES

11.1 Standard References *(Applicable to all AF installations)*

- AFI 32-7064, *Integrated Natural Resources Management*
- Sikes Act
- eDASH Natural Resources Program Page
- Natural Resources Playbook – a Internal AF reference available at https://cs1.eis.af.mil/sites/ceportal/CEPlaybooks/NRM2/Pages/

11.2 Installation References

- Bailey, R. G. 2014. ***Ecoregions: The ecosystem geography of the oceans and continents*** (Second). New York: Springer.
- Baker J.C., T. Lychlyter, and D.A. Ledbetter. 2001-2006. ***In-house Sighting of Sensitive Species.*** Wildlife Services United States Department of Agriculture (WS-USDA), Natural Resources Program, Tinker AFB, Oklahoma.
- Baker, J.C. and M.S. Gage. 2008-2011. ***In-house Sighting of Sensitive Species.*** Wildlife Services United States Department of Agriculture (WS-USDA). Natural Resources Program, Tinker AFB, Oklahoma.
- Barbour, M. T., Gerritsen, J., Snyder, B. D., and Stribling, J. B. 1999. ***Rapid Bioassessment Protocols for Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates***

and Fish, Second Edition, EPA 841-B- 99-002, U.S. Environmental Protection Agency, Office of Water, Washington, D.C.

- Baumgartner, F.M. and A.M. Baumgartner. 1992. ***Oklahoma Bird Life***. University of Oklahoma Press.
- Bennett, A.M., M. Keevil, and J.D. Litzgus. 2009. ***Demographic Differences Among Populations of Northern Map Turtles (Graptemys geographica) in Intact and Fragmented sites.*** Canadian Journal of Zoology 87:1147- 1157.
- Bingham R.H., and R.L. Moore. 1975. ***Reconnaissance of the Water resources of the Oklahoma City Quadrangle, Central Oklahoma.*** Oklahoma Geological Survey Hydrologic Atlas 4. 1975.
- Bogosian, V., Cook, M.T., and Moody, R.W. (2009) ***Phrynosoma cornutum, Texas horned lizard, Reproduction.*** *Herpetological Review*. Vol. 40, No 3. Sep 2009.
- Bogosian, V., Hellgren E.C., and Moody, R.W. (2010) ***A Technique to Test Hypotheses Regarding Social Spacing Patterns in Cryptic Organisms: Minta's Test Revisited.*** *Animal Behavior (accepted - under revision).*
- Bogosian, V., Hellgren E.C., and Moody, R.W. (2011) ***Herptile and Mammal Assemblages on an Urban Military Base in Oklahoma.*** *Southwestern Naturalist (in press).*
- Bogosian, V., Hellgren E.C., Sears M. and Moody, R.W. (2011) ***A High-Resolution Niche Suitability Model Combining Correlative and Process-Based Approaches.*** *Ecological Modeling 237-238 (2012) 63-73.*
- Bogosian, V.B. III, E.C. Hellgren and R.W. Moody. 2011 (in-press). ***Reptile, Amphibian, and Mammal Assemblages on an Urban Military Base in Oklahoma.*** Southwestern Naturalists (*number pending*).
- Both, C., Van Turnhout, C. A. M., Bijlsma, R. G., Siepel, H., Van Strien, A. J., & Foppen, R. P. B. 2010. ***Avian population consequences of climate change are most severe for long-distance migrants in seasonal habitats.*** Proceedings of the Royal Society B: Biological Sciences, 277(1685), 1259–1266. http://doi.org/10.1098/rspb.2009.1525
- Bowen, K.D., P.L. Colbert, and F.J. Janzen. 2005. ***Survival and Recruitment in a Human-impacted Population of Ornate Box Turtles, Terrapene ornate, with Recommendations for Conservation and Management.*** Journal of Herpetology 38:562-568.
- Burnham, K. P., D. R. Anderson, and J. L. Laake. 1980. ***Estimation of density from line transect sampling of biological populations.*** Wildlife Monographs 72.
- CIRE, Richard Hauer, Ph.D., in conjunction with Tetra Tech, Inc., Nathan A. Schwab, M.S. 2016. ***USAF Installations in the Midwest United States (Project # - AFCE576326).*** At 14 Air Force Bases: *To Provide Surveys of Proposed and Recently Listed Species (Bats) under the Endangered Species Act on: Altus AFB, Cavalier AFS, Dyess AFB, Ellsworth AFB, Grand Forks AFB, Little Rock AFB, Mc Connell AFB, Minot AFB, Offutt AFB, Scott AFB, Sheppard AFB, Tinker AFB, Whiteman AFB, and Wright-Patterson AFB*. This Final Report UM-CIRE_0011.2 (2016) is in compliance with the Northwestern Division, Omaha District, U.S. Army Corps of Engineers Cooperative Agreement W9128F-14-2-0002.
- CH2MHILL. 1998. ***Thirteen-lined Ground Squirrel Study Tinker AFB.*** Contracted Survey for Tinker Air Force Base, Oklahoma.
- Congdon J.D., A.E. Dunham, and R.C. VanLoben Sels. 1993. ***Delayed Sexual Maturity and Demographics of Blanding's Turtles (Emydoidea blandingii): Implications for Conservation and Management of Long-lived Organisms.*** Conservation Biology 7:826–833.
- Conner, C.A., B.A. Douthitt and T.J. Ryan. 2005. ***Descriptive Ecology of a Turtle Assemblage in an Urban Landscape.*** American Midland Naturalist 153:428-435.

- Converse, S.J., J.B. Iverson, and J.A. Savidge. 2005. ***Demographics of an Ornate Box Turtle Population Experiencing Minimal Human-induced Disturbances.*** Ecological Applications 15:2171-2179.
- DoD. 2014. ***DoD 2014 Climate Adaptation Roadmap***, 16.
- Dodd, C.K., and M.J. Dreslik. 2008. ***Habitat disturbances differentially affect individual growth rates in a long-lived turtle***. Journal of Zoology 275:18-25.
- Dorr, J. L., P. Swint and V.R. Emrick. 2005. ***Tinker Air Force Base Vegetative Communities Map and Vegetation Classification Systems.*** Conservation Management Institute-Military Lands Division, College of Natural Resources, Virginia Polytechnic Institute and State University. CMI-MLD-2005-R-34.
- Dorr, J.L and M.J. St. Germain. 2010. ***Oklahoma Penstemon (Penstemon oklahomensis) Survey on Tinker Air Force Base, Oklahoma City, Oklahoma.*** Conservation Management Institute, Virginia Polytechnic Institute and State University, College of Natural Resources and Environment, Blacksburg, Virginia.
- Dorr, J.L. 2007. ***Oklahoma Penstemon Monitoring at Tinker Air Force Base.*** Conservation Management Institute- Military Lands Division, College of Natural Resources, Virginia Polytechnic Institute and State University. CMI-2007-R-45.
- Dorr, J.L. and B. Pokorski. 2007. ***Nonnative/Invasive Plant Species in the Urban Greenway, Tinker Air Force Base, Oklahoma.*** Conservation Management Institute-Military Lands Division, College of Natural Resources, Virginia Polytechnic Institute and State University. CMI-MLD R-47.
- Dorr, J.L., J. Otey, and P.E. Wiseman. 2007. ***Tinker Air Force Base Urban Tree Inventory.*** Conservation Management Institute and Department of Forestry, College of Natural Resources, Virginia Polytechnic Institute and State University. CMI-MLD R-48.
- Dorr, J.L., P. Swint, and V.R. Emerick. 2005. ***Tinker Air Force Base Vegetative Communities Map and Vegetation Classification System.*** Conservation Management Institute-Military Lands Division, College of Natural Resources, Virginia Polytechnic Institute and State University. CMI-MLD-2005-R-34.
- Dukes, J. S., & Mooney, H. A. 1999. ***Does global change incraese the success of biological invaders?*** Tree, 14(4), 135–139. http://doi.org/http://dx.doi.org/10.1016/S0169-5347(98)01554-7
- Endriss D.A. 2006. ***Ecology of an Urban Population of The Texas Horned Lizard (Phrynosoma cornutum) in Central Oklahoma.*** Master's Thesis, Oklahoma State University.
- Endriss, D.A., E.C. Hellgren, S.F. Fox, and R.W. Moody. 2007. ***Demography of an Urban Population of the Texas Horned Lizard (Phrynosoma cornutum) in Central Oklahoma.*** Herpetologica: Vol. 63, No. 3 pp. 320-331, Department of Biological Sciences Emporia State University, Emporia, KS 66801, ISSN # 0018-0831, Sep 2007.
- Endriss, D.A., E.C. Hellgren, S.F. Fox, and R.W. Moody. 2004. ***Movements and Demographic Characteristics of an Urban Population of the Texas horned lizard.*** Oklahoma Academy of Science, Edmond, Oklahoma.
- Endriss, D.A., E.C. Hellgren, S.F. Fox, and R.W. Moody. 2005. ***Habitat Use and Ecology of an Urban Population of the Texas Horned Lizard.*** The Southwestern Naturalist, 52nd Annual Meeting, Sam Houston State University, Huntsville, TX.
- Endriss, D.A., E.C. Hellgren, S.F. Fox, and R.W. Moody. ***Characteristics of Hibernation and Nest Sites of Phrynosoma cornutum in Central Oklahoma.*** Journal of Herpetology,

Society for the Study of Amphibians and Reptiles, P.O. Box 58517, Salt Lake City, UT 84158, Dec 2006.

- Eskew, E.A., S.J. Price, and M.E. Dorcas. 2010. ***Survival and Recruitment of Semiaquatic Turtles in an Urbanized Region.*** Urban Ecosystems: In press. DOI 10.1007/s11252-010-0125-8.
- Executive Order (E.O.) 12962. 2008. ***Recreational Fisheries.*** As amended by E.O., 13474 on September 26, 2008.
- Franklin C.J. 1997. ***Geographical Distribution (Hemidactlyus turcicius).*** Herpetological Review 28 (2): 96.
- Fuller P.L., L.G. Nico, and J.D. Williams. 1999. ***Nonindigenous Fishes Introduced into Inland Waters of the United States.*** USGS & USFWS, American Fisheries Society, Special Publication 27, Bethesda Maryland.
- Gent, P. R., & Danabasoglu, G. 2011. ***The Community Climate System Model version 4***. Journal of Climate, 24, 4973–4991.
- Glenn, S.M., L.E. Watson, and B. Hoagland. 1993. ***Vegetation Inventory of Tinker Air Force Base, Oklahoma.*** Natural Resources, Tinker Air Force Base, Oklahoma.
- Glick, P., Stein, B. A., & Edelson, N. A. 2011. ***Scanning the Conservation Horizon***. National Wildlife Federation. Washington, D.C.
- Halls K.L. 1984. ***White-tailed Deer; Ecology and Management.*** Wildlife Management Institute, Stackpole Books, Harrisburg, PA.
- Hellgren, E.C. and V. Bogosian III. 2009. ***Baseline Survey of Presence or Absence of Mammalian, Reptilian and Amphibian Populations on Tinker Air Force Base, with Estimations of Population Demographics and Size Final Report.*** Cooperative Wildlife Research Laboratory Department of Zoology, Southern Illinois University, Carbondale, IL.
- Hellmann, J. J., Byers, J. E., Bierwagen, B. G., & Dukes, J. S. 2008. ***Five potential consequences of climate change for invasive species.*** Conservation Biology, 22(3), 534–543. http://doi.org/10.1111/j.1523-1739.2008.00951.x
- Hempel, S., Frieler, K., Warszawski, L., Schewe, J., & Piontek, F. 2013. ***A trend-preserving bias correction; the ISI-MIP approach.*** Earth System Dynamics, 4(2), 219–236. http://doi.org/10.5194/esd-4-219-2013
- Hibbard, K. A., Meehl, G. A., Cox, P. M., & Friedlingstein, P. 2007. ***A strategy for climate change stabilization experiments.*** Eos, 88(20), 217–221. http://doi.org/10.1029/2007EO200002
- Hurrell, J. W., Holland, M. M., Gent, P. R., Ghan, S., Kay, J. E., Kushner, P. J., … Marshall, S. 2013. ***The community earth system model: A framework for collaborative research.*** Bulletin of the American Meteorological Society, 94(9), 1339–1360. http://doi.org/10.1175/BAMS-D-12-00121.1
- Johnson, F.L., M.D. Proctor, T.L. Browning, G.E. Brown, and G.D. Schnell. 1995. ***Native Tallgrass Prairie Assessment/Management Plan.*** Natural Resources, Tinker Air Force Base, Oklahoma.
- Knaus, S. 1995. ***Protected Species Surveys Tinker Air Force Base Oklahoma.*** Geo-Marine, Inc., U.S. Army Corps of Engineers Contract No DACW56-92-C-0010.
- Knaus, S., R.W. Moody and J.R. Krupovage. 1995. ***Protected Species Surveys Tinker Air Force Base Oklahoma.*** Geo-Marine, Inc., U.S. Army Corps of Engineers, Contract No DACW56-92-C-0010.

- Krebs, C.J. 1999. ***Ecological Methodology***. Addison-Welsey Educational Publishers Inc. Menlo Park, CA. Lemmons, R., R.W. Moody and C. Lemmons. 2005. ***Investigating the Stream Fishes of Tinker Air Force Base.***
- Kuo, C.H., and F.J. Janzen. 2004. ***Genetic Effects of a Persistent Bottleneck on a Natural Population of Ornate Box Turtles (Terrapene ornata).*** Conservation Genetics 5:425-437.
- Leslie, M., G.K. Meffe, J.L. Hardesty, and D.L. Adams. 1996. Con***serving Biodiversity on Military Lands: A Handbook for Natural Resources Managers***. The Nature Conservancy, Arlington, VA.
- Mack, J.J. 2001. ***Ohio Rapid Assessment Method for Wetlands v. 5.0, User's Manual and Scoring Forms,*** *Ohio EPA Technical Report WET/2001-1, Ohio Environmental Protection Agency, Division of Surface Water, 401/Wetland Ecology Unit, Columbus, Ohio.*
- Marsh-Matthews E., and W.J. Matthews. 2010. ***Comparisons of the Fish Assemblages of the Crutcho Creek Drainage Basin, Oklahoma.*** Annual Report to Tinker AFB, OK, USAMRA Contract No W81XWH0920034 D001.
- Matthews W.J. 1998. ***Patterns in freshwater fish ecology***. Chapman and Hall, New York.
- Matthews, W. J. 1987. ***Community and Evolutionary Ecology of North American Stream Fishes.*** Physicochemical tolerance and selectivity of stream fishes as related to their geographic ranges and local distributions. Pp. 111-120, in W. J. Matthews and D. C. Heins (eds.). University of Oklahoma Press, Norman, OK.
- Matthews, W.J. and F.P. Gelwick. 1990. ***Fishes of Crutcho Creek and the North Canadian River in Central Oklahoma: effects of urbanization.*** Southwestern Naturalist 35:403-410.
- McNeff, L.B. (2008) ***DINOSAURS at Tinker Air Force Base (photos and quotes by R.W. Moody).*** Outdoor Oklahoma: Vol 64, No. 5 pp. 4-5, Oklahoma Department of Wildlife Conservation, PO Box 53465, Oklahoma City, OK. 73152, ISSN # 0030-7106, Sep – Oct 2008.
- Messick, J.A. 2012. ***The Life History and Biography of Penstemon oklahomensis: A Southern Plains Endemic.*** Master's Thesis, University of Oklahoma.
- Messick, J.A. and B.W. Hoagland. 2012. ***Penstemon oklahomensis (Plantaginaceae) Habitat in Oklahoma.*** Proceedings of the Oklahoma Academy of Science. 92: pp 37-46.
- Messick, J.A. and B.W. Hoagland. 2013. ***Potential Distribution Modeling of Penstemon oklahomensis (Plantaginaceae).*** Journal of the Botanical Research Institute of Texas. 7(2):891-899.
- Miller K.V. and R.L. Marchinton. 1995. ***Quality Whitetails; The Why and How of Quality Deer Management.*** Stackpole Books, Mechanicsburg, PA.
- Miller, J.H., E.B. Chambliss, and N.J. Loewenstein. ***A Field Guide for the Identification of Invasive Plants in Southern Forests.*** United States Department of Agriculture, Forest Service, Southern Research Station, General Technical Report SRS-119.
- Miller, R.J., and H.W. Robison. 2004. ***Fishes of Oklahoma***, 2nd edition. University of Oklahoma Press, Norman, Oklahoma.
- Moody R. W. and J.R. Krupovage. 1992-2011. ***In-house Sighting of Sensitive Species.*** Natural Resources Program, Tinker AFB, Oklahoma.
- Moody R. W., H. Saxion, A. Allen, H. Dyke, V. Farris, and D. Reilly. 2000. ***Implementation of Interim and Long-term Pest Bird Management Programs.*** Natural Resources Program, Tinker AFB, Oklahoma.
- Moody R.W. 2002-2005. ***White-tailed Deer Spotlight Survey for the Glenwood Area at Tinker AFB,*** In-house surveys using Nobel Foundation Methodology for determining density of white-tailed deer in the Glenwood Areas of Tinker AFB, Oklahoma.

- Moody, R.W., (2005) ***Texas Horned Lizards on Tinker Air Force Base in Oklahoma?*** Phrynosomatics, Horned Lizard Conservation Society, Austin TX. August 2005.
- Moody, R.W., (2008) ***Texas horned lizard (photo).*** Outdoor Oklahoma: Vol 64, No. 4, Oklahoma Department of Wildlife Conservation, PO Box 53465, Oklahoma City, OK. 73152, ISSN # 0030-7106, Jul – Aug 2008.
- Moody, R.W., E. Hellgren, D.A. Endriss, and S.F. Fox. (2006) ***Studying a Population of Texas Horned Lizards (Phrynosoma cornutum) in an Urban/Military Environment.*** IGUANA Conservation, Natural History, and Husbandry of Reptiles, International Reptile Conservation Foundation, 3010 Magnum Drive, San Jose CA. 95135, ISSN # 1098-6324, Nov 2006.
- Moss, R. H., Babiker, M., Brinkman, S., Calvo, E., Carter, T., Edmonds, J., … Zurek, M. 2008. ***Technical Summary: Towards New Scenarios for Analysis of Emissions, Climate Change, Impacts and Response Strategies.*** IPCC Expert Meeting Report, 25. http://doi.org/10.1086/652242
- Moss, R. H., Edmonds, J. A., Hibbard, K. A., Manning, M. R., Rose, S. K., van Vuuren, D. P., … Wilbanks, T. J. 2010. ***The next generation of scenarios for climate change research and assessment.*** Nature, 463(7282), 747–756. http://doi.org/10.1038/nature08823
- NatureServe. 2011. **NatureServe Explorer: An Online Encyclopedia of Life**. Version 7.1. NatureServe, Arlington, Virginia. Available at http://www.natureserve.org/explorer. (Accessed: 17 June 2011).
- North American Bird Conservation Initiative, U.S. Committee. 2011. ***The State of the Birds 2011 Report on Public Lands and Waters.*** U.S. Department of Interior: Washington, DC. 48 pages.
- Oklahoma Biodiversity Task Force. 1996. ***Oklahoma's Biodiversity Plan: A Shared Vision for Conserving Our Natural Heritage.*** (Norman L. Murray, Editor). Oklahoma Department of Wildlife Conservation, Oklahoma City, Oklahoma.
- Oklahoma Department of Wildlife Conservation. 2005. ***Oklahoma Comprehensive Wildlife Conservation Strategy***. Oklahoma City, Oklahoma.
- Oklahoma Invasive Plant Council. 2011. ***Oklahoma Non-Native Invasive Plant Species.*** Oklahoma Native Plant Society, Oklahoma Biological Survey, and OSU Natural Resources Ecology and Management. Available from: http://ok-invasive-plant-council.org/images/OKinvasivespp.pdf. Accessed: 15 Apr 2011.
- Oklahoma Water Resources Board (OWRB). 1993. ***Oklahoma Water Quality Standards.*** Chapter 45, OAC 785:45, OWRB.
- Paerl, H. W., Hall, N. S., & Calandrino, E. S. 2011. ***Controlling harmful cyanobacterial blooms in a world experiencing anthropogenic and climatic-induced change.*** Science of the Total Environment, 409(10), 1739–1745. http://doi.org/10.1016/j.scitotenv.2011.02.001
- Palmer R. 2006. ***Tinker AFB Integrated Pest Management Plan.*** CSP Operations, Tinker AFB, Oklahoma.
- Parkinson, A. J., & Butler, J. C. 2005. ***Potential impacts of climate change on infectious diseases in the Arctic.*** International Journal of Circumpolar Health, 64(5), 478–486. http://doi.org/10.3402/ijch.v64i5.18029
- Piagio, A. J., & Perkins S. L. 2005. **Molecular phylogeny of North American long-eared bats (Vespertilionidae: Corynrhinus); inter- and intraspecific relationships inferred from mitochondrial and nuclear DNA sequences.** Molecular Phylogenetics and Evolution, 37:762-775.
- Pierce, D. W., Cayan, D. R., & Thrasher, B. L. 2014. ***Statistical Downscaling Using Localized***

Constructed Analogs (LOCA)*. Journal of Hydrometeorology, 15(6), 2558–2585. http://doi.org/10.1175/JHM-D-14-0082.1

- Plummer M.V., D.G. Krementz, L.A. Powell, and N.E. Mills. 2008. ***Effects of Habitat Disturbance on Survival Rates of Softshell Turtles (Apalone spinifera) in an Urban Stream.*** Journal of Herpetology 42:555-563.
- Poff, N. L., Brinson, M. M., & Day, J. W. 2002. ***Aquatic Ecosystems & Global Climate Change: Potential Impacts on Inland Freshwater and Coastal Wetland Ecosystems in the United States.*** Prepared for the Pew Center on Global Climate Change, (January), 1–56. http://doi.org/10.1039/b211160h
- Richards, N.A.1983. ***Diversity and Stability in a Street Tree Population.*** Urban Ecology 7.
- Rizkalla, C.E., and R.K. Swihart. 2006. ***Community Structure and Differential Responses of Aquatic Turtles to Agriculturally Induced Habitat Fragmentation.*** Landscape Ecology 21:1361-1375.
- Santamour, F.S., Jr. 1990. ***Trees for Urban Planting: Diversity, Uniformity, and Common Sense.*** Proc. 7th.
- Science Applications International Corporation (SAIC). 2003. ***Wetlands Study Report for Tinker AFB.*** SAIC Oak Ridge, Tennessee.
- Science Applications International Corporation (SAIC). 2008. ***Wetlands Study Report for Tinker AFB.*** SAIC Oak Ridge, Tennessee.
- Sibley, D.A. 2009. ***The Sibley Guide to Birds.*** National Audubon Society, Alfred A. Knopf Publishing, Random House, Inc. Published 2000, Tenth Printing 2009. ISBN 978-0-679-45122-8.
- St. Germain, M. J. 2010. ***Inventory of Avian Species on Tinker Air Force Base (AFB) Oklahoma City, Oklahoma.*** Conservation Management Institute, Virginia Polytechnic Institute and State University, College of Natural Resources and Environment, Blacksburg, Virginia.
- Süss, J., Klaus, C., Gerstengarbe, F. W., & Werner, P. C. 2008. ***What makes ticks tick? Climate change, ticks, and tick-borne diseases.*** Journal of Travel Medicine, 15(1), 39–45. http://doi.org/10.1111/j.1708-8305.2007.00176.x
- Sutton G.M. 1977. ***Fifty Common Birds of Oklahoma and the Southern Great Plains.*** University of Oklahoma Press, Norman, Oklahoma.
- Swingle H.S. 1956, and Hill L.G. 1989, and R.W. Moody. 2010. ***Swingle - Appraisal of Methods of Fish Population Study and Hill - Zoology 6693 University of Oklahoma – class notes, and Moody - Modifications to Presentation of Data.*** Transactions of North American Wildlife 21:298-322.
- Sydeman, W. J., García-Reyes, M., Schoeman, D. S., Rykaczewski, R. R., Thompson, S. A., Black, B. A., & Bograd, S. J. 2014. ***Climate change and wind intensification in coastal upwelling ecosystems.*** Science, 345(6192), 77–80. http://doi.org/10.1126/science.1251635
- Tabit, C. R., and G. Johnson. 2002. ***The Biodiversity and Distribution of Fish in a Southeastern Upper Piedmont Drainage.*** Southeastern Naturalist 1(3):253-268.
- Taylor, R.J. and C.E.S. Taylor. 1994. ***An Annotated List of the Ferns, Fern Allies, Gymnosperms and Flowering Plants of Oklahoma.*** 3rd Edition. Biology Department Herbarium, Southeastern Oklahoma State University, Durant, Oklahoma.
- The Oklahoma Academy of Science, 94th Annual Technical Meeting, Oklahoma City University, OK.
- Thornton, P., Thornton, M., & Mayer, B. 2012. ***DAYMET: Daily Surface Weather on a 1 km Grid for North America.*** 1980–2008. ... Center, Oak Ridge, T, N. Doi. http://doi.org/10

- Tinker Air Force Base. 2007. ***Natural Resources Marketing Blueprint (Draft Report).*** Environmental Management Division, 72 ABW/CEVOE, Tinker Air Force Base Oklahoma.
- Tinker Air Force Base. 2011. ***Integrated Cultural Resources Management Plan for Tinker Air Force Base.*** Civil Engineering Directorate, 72 ABW/CEANO, Tinker Air Force Base, Oklahoma.
- United States Army Corps of Engineers (USACE). 2002. ***Tinker Air Force Base Floodplain Study, Oklahoma County Oklahoma.*** USACE Southwestern Division Tulsa District, Oklahoma.
- United States Department of Agriculture. 1969, 1983 and 1996. ***Soil Survey – Oklahoma County, Oklahoma.*** Natural Resources Conservation Service (NRCS), US Government Printing Office. Washington, D.C. 56 pp. 1969, revised 1983 and 1996.
- U.S. Environmental Protection Agency. 2005. ***Level III ecoregions of the continental United States*** (revision of Omernik, 1987): Corvallis, Oregon, USEPA–National Health and Environmental Effects Research Laboratory, Western Ecology Division, Map M-1, various scales.
- USGCRP. 2017. ***Climate Science Special Report: Fourth National Climate Assessment, Volume I.*** (D. J. Wuebbles, D. W. Fahey, K. A. Hibbard, D. J. Dokken, B. C. Stewart, & T. K. Maycock, Eds.). Washington, DC. http://doi.org/10.7930/J0J964J6
- White, G.C. and K. P. Burnham. 1999. ***Program Mark: survival estimations from populations of marked animals.***
- Wood P.R., and L.C. Burton. 1968. ***Ground-water resources in Cleveland and Oklahoma Counties, Oklahoma.*** Oklahoma Geological Survey Circular 71.
- Wood S.D., and G.D. Schnell. 1984. ***Distributions of Oklahoma Birds.*** University of Oklahoma Press, Norman Oklahoma.

12.0 ACRONYMS

12.1 Standard Acronyms (Applicable to all AF installations)

- Natural Resources Playbook – Acronym Section
- U.S. EPA Terms & Acronyms

12.2 Installation Acronyms

- **AAFES –** Army and Air Force Exchange Service
- **ABW –** Air Base Wing
- **ACC –** Air Combat Command
- **ACW –** Air Control Wing
- **AF –** Air Force
- **AFB –** Air Force Base
- **AFCEC –** Air Force Civil Engineer Center
- **AFI –** Air Force Instruction
- **AFPD –** Air Force Policy Directive
- **AFRIMS –** Air Force Records Information Management System
- **AFSC –** Air Force Sustainment Center
- **AICUZ –** Air Installation Compatible Use Zone
- **AOA –** Air Operations Area
- **APZ –** Accident Potential Zone
- **AREP –** Aquatic Resources Education Program
- **BASH –** Bird/Wildlife Aircraft Strike Hazard
- **CCDB** – Crutcho Creek Drainage Basin
- **CE** – Civil Engineering

- **CEIG –** Cyber Engineering Installation Group
- **CEMML –** Center for Environmental Management of Military Lands
- **CERCLA –** Comprehensive Environmental Response, Compensation, and Liability Act
- **CERL –** Construction Engineering Research Lab
- **CESU –** Cooperative Ecosystem Study Unit
- **CFR –** Code of Federal Regulations
- **CIRE –** Center for Integrated Research on the Environment
- **CNG –** Compressed Natural Gas
- **CWD –** Chronic Wasting Disease
- **CZ –** Clear Zone
- **DASD –** Deputy Assistant Secretary of Defense
- **DBH –** Diameter at Breast Height
- **DoD –** Department of Defense
- **DoDI –** Department of Defense Instruction
- **DRMO –** Defense Reutilization and Marketing Office
- **ECAMP** – Environmental Compliance Assessment and Management Program
- **EIAP –** Environmental Impact Analysis Process
- **EIG** – Engineering Installation Group
- **EMP –** Environmental Management Plan
- **EMS** – Environmental Management System
- **EPA –** Environmental Protection Agency
- **EQ –** Environmental Quality
- **ERMS** – Electronic Records Management System
- **ESOH** – Environmental Safety and Occupational Health
- **eSSS –** Electronic staff summary sheet
- **FCF** – Fuel Control Facility
- **FGS –** Final Governing Standards
- **FLETC –** Federal Law Enforcement Training Center
- **FONPA** – Finding of No Practicable Alternative
- **FSS –** Force Support Squadron
- **G** – Global (rank)
- **GEM –** Golf Course Environmental Management Plan
- **GI** – Green Infrastructure
- **GIS** – Geographic Information System
- **GPS** – Global Positioning System
- **GSU –** Geographically Separated Unit
- **GWTP** – Ground Water Treatment Plant
- **HQ AFMC –** Headquarters Air Force Materiel Command
- **IAW –** In accordance with
- **ICRMP –** Integrated Cultural Resources Management Plan
- **IDP –** Installation Development Plan
- **INRMP –** Integrated Natural Resources Management Plan
- **IPaC –** Information for Planning and Consultation
- **IPM –** Integrated Pest Management
- **IPMP –** Integrated Pest Management Plan
- **IST –** Installation Support Team
- **ITNS –** Information Transfer Node System

- **IUCN –** International Union for Conservation of Nature
- **JI –** Jaccard's Index
- **JLUS –** Joint Land Use Study
- **JROTC** – Junior Reserve Officers' Training Corps
- **LIDAR** – Land Detection and Ranging
- **LTA** – Leased Training Area
- **MBTA –** Migratory Bird Treaty Act
- **MICT –** Management Internal Control Toolset
- **MIPR –** Military Interdepartmental Purchase Request
- **MROTC** – Maintenance, Repair and Overhaul Technology Center
- **MSL –** Mean Sea Level
- **NATO –** North Atlantic Treaty Organization
- **NCAR –** National Center for Atmospheric Research
- **NGO –** Non-governmental organization
- **NMFS –** National Marine Fisheries Service
- **NOAA –** National Oceanic and Atmospheric Administration
- **NPDES –** National Pollutant Discharge Elimination Systems
- **NR –** Natural Resources
- **NRCS –** Natural Resources Conservation Service
- **NRM –** Natural Resources Manager
- **OAC –** Oklahoma Administrative Code
- **OC-ALC** – Oklahoma City Air Logistics Complex
- **OCAMA –** Oklahoma City Air Materiel Area
- **OCC –** Oklahoma Corporation Commission
- **ODEQ** – Oklahoma Department of Environmental Quality
- **ODWC** – Oklahoma Department of Wildlife Conservation
- **ONHI** – Oklahoma Natural Heritage Inventory
- **ORAM** – Ohio Rapid Assessment Method for Wetlands
- **OSU** – Oklahoma State University
- **OWQS** – Oklahoma Water Quality Standards
- **OWRB –** Oklahoma Water Resources Board
- **PC –** Personal Computer
- **POC –** Point of contact
- **PPAP –** Pollinator Partnership Action Plan
- **PRECIP –** Average Annual Precipitation
- **PSI –** Percent Similarity Index
- **RBP –** Rapid Bioassessment Protocol
- **RCP –** Representative Concentration Pathway
- **RCRA –** Resource Conservation and Recovery Act
- **RDS –** Records Disposition Schedule
- **REPI –** Readiness and Environmental Protection Integration
- **RIFA –** Red Imported Fire Ant
- **RV** – Recreational Vehicle
- **S** – State (rank)
- **SAIC** – Science Applications International Corporation

- **SAR –** Species at Risk
- **SIU** – Southern Illinois University
- **SME –** Subject Matter Expert
- **SMS –** Subject Matter Specialist
- **SOW –** Statement of Work
- **STP** – Sanitary Treatment Plant
- **SWPP –** Storm Water Pollution Prevention
- **TAFB** – Tinker Air Force Base
- **TAC –** Tinker Aerospace Complex
- **TAVE –** Annual Average Temperature
- **TERPS** – Terminal Instrument Procedures
- **THL –** Texas Horned Lizard
- **TMAX –** Annual Average Maximum Temperature
- **TMIN –** Annual Average Minimum Temperature
- **TTO –** Tinker Take Off
- **UEC –** Unit Environmental Coordinator
- **UFC –** Unified Facilities Criteria
- **UFWG** – Urban Forestry Working Group
- **USA –** United States of America
- **USACE** – United States Army Corps of Engineers
- **USAF** – United States Air Force
- **USAO –** University of Science and Arts of Oklahoma
- **USDA-WS** – United States Department of Agriculture—Wildlife Services
- **USFWS –** United States Fish and Wildlife Service
- **UV –** Ultraviolet
- **WDM –** Wildlife Damage Management
- **WFMP –** Wildland Fire Management Plan

13.0 DEFINITIONS

13.1 Standard Definitions (Applicable to all AF installations)

- Natural Resources Playbook – Definitions Section

13.2 Installation Definitions

- Add unique state, local and installation-specific definitions

14.0 APPENDICES (Appendices are attached as separate documents)

Appendix A: Annotated Summary of Key Legislation Related to Design/Implementation of the INRMP

Appendix B: Natural Resources Annual Reports

Appendix C: Flora List

Appendix D: Fauna List

Appendix E: Native Landscaping Plant Material List

Appendix F: Mitigation Action Tracker

Appendix G: Urban Forestry Management Procedures

Appendix H: Natural Resources Cooperative Agreements/Memorandums

Appendix I: Species at Risk

Appendix J: Natural Resources Equipment and Supply Inventory

15.0 ASSOCIATED PLANS (Tabs 1, 2, 3, and 8 are attached as separate documents. Refer to OPRs for other plans)

Tab 1 – Green Infrastructure (GI) Plan

Tab 2 – Golf Course Environmental Management (GEM) Plan

Tab 3 – Wildland Fire Management Plan (WFMP)

Refer to Green Infrastructure Plan (Tab 1) for current WFMP.

Tab 4 – Bird/Wildlife Aircraft Strike Hazard (BASH) Plan

Refer to plan OPR (Tinker Flight Safety office)

Tab 5 – Integrated Pest Management Plan (IPMP)

Refer to plan OPR (Tinker Installation Pest Management Coordinator)

Tab 6 – Integrated Cultural Resources Management Plan (ICRMP)

Refer to plan OPR (Tinker Cultural Resources Program Manager)

Tab 7 – Storm Water Management Plan

Refer to plan OPR (Tinker Storm Water Program Manager)

Tab 8 – Climate Change Supporting Information

Refer to information OPR (Tinker Natural Resources Program Manager)