The National 4-H

Wildlife Habitat Education Program

Sixth Edition
(2024)

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Acknowledgements
Lynn Barrett, GIS analyst with the Tennessee Wildlife Resources Agency, produced the ecoregion maps and species range maps used in the species profiles. Heather Inman, Kristy Keel-Blackmon, and Katie Donaldson, University of Tennessee School of Natural Resources, constructed the layout. April Massengill Moore, University of Tennessee Institute of Agriculture Marketing and Communications, served as text editor. Rich Maxey, University of Tennessee Institute of Agriculture Marketing and Communications, designed the WHEP logo. All photos not credited were taken by Craig Harper.

Many people have been involved in writing and preparing the National 4-H Wildlife Habitat Education Program manual over the years. This edition represents the 5th major revision. Editors of previous editions included:

First and Second Editions
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UT Extension publication number: PB 1827

History of the National 4-H Wildlife Habitat Education Program

The Wildlife Habitat Education Program (WHEP) began in 1978 under the direction of Dr. James L. Byford, Extension Wildlife Specialist, and Dr. Thomas K. Hill, Extension Fisheries Specialist, at the University of Tennessee. Drs. Byford and Hill realized the passion youth have for wildlife and initiated the **Tennessee 4-H Wildlife Judging Contest**, which was modeled after the popular 4-H livestock judging contests. The program was immediately accepted throughout Tennessee. A conference was held in 1985 to explore the possibility of a Southern Region Program. The first Southern Region Invitational was held in 1987. In 1988, the second Southern Region Invitational was supported by the International Association of Fish and Wildlife Agencies, and a conference was held concurrently to discuss the possibility of a National Invitational. In 1989, the program was expanded nationally and the first National Invitational was held with the support of the U.S. Fish and Wildlife Service and the International Association of Fish and Wildlife Agencies.

The first edition of this manual was produced in 1990-91 with sponsorship by Champion International Corporation and the U.S. Fish and Wildlife Service. The new national program was called the **National 4-H Wildlife Habitat Evaluation Program**. The manual was revised in 1998-99 to incorporate new information in wildlife science and management. The Ruffed Grouse Society, Rocky Mountain Elk Foundation, and the USDA Cooperative State Research, Education and Extension Service were added as sponsors of the manual revision. The manual incorporated the basic concepts originated by Byford and Hill with the addition of ecoregions across the U.S. and a wider array of wildlife management practices and wildlife species. Since 1991, the manual has undergone several major revisions, each incorporating new information, revision of contest activities, and additional species. This process is important and highlights the need to incorporate additional information as research makes it available and as interest among participants changes. This Sixth Edition incorporates new species, revision of wildlife management practices and concepts, and revision of rules for the contest.

Starting in 2010, FFA teams were invited to compete in WHEP. FFA teams and 4-H teams do not compete against each other, but rather against teams within each organization. Additionally, in 2010, the name **Wildlife Habitat *Evaluation* Program** was changed to **Wildlife Habitat *Education* Program** to reflect the intent of the program to provide curriculum on wildlife management in addition to the contest format. WHEP was acknowledged with the Conservation Education Award by The Wildlife Society in 1996 and earned the 4-H National Program of Distinction Award in 2011.

This manual is intended for use in preparing for the National WHEP Invitational as well as state and local educational programs. It is the intent of the organizers to move the national contest to different locations each year. This manual is designed to provide uniformity for the program and provide wildlife management information using representative species occupying major ecoregions across the U.S.

Table of Contents

Introduction

The National 4-H Wildlife Habitat Education Program (WHEP) is designed to teach youth the fundamentals of wildlife and fisheries science and management. WHEP is an official 4-H program. However, the National Invitational contest is open to FFA participants as well. The National Invitational is open only to senior division 4-H members or FFA participants. Junior division and junior-high 4-H members are eligible to compete at county, regional (within a state), and/or state events.

In this program, youth learn how management for wildlife includes managing land, water, and populations. The manual and activities are focused not only on increasing knowledge in wildlife management, but also on developing skills to apply that knowledge. Additional benefits include development of life skills, such as decision-making, leadership, written and oral communication, and meeting other young people and professionals from around the country who have interests in natural resources.

It is important to understand ecological processes as well as life requirements of various wildlife species before making management recommendations. The **Concepts and Terms**, **Ecoregions**, **Wildlife Species**, and **Wildlife Management Practices** sections of this manual provide basic information related to wildlife ecology and management as well as the life requirements of various wildlife species. The **Wildlife Challenge** (Activity I) allows participants to showcase their knowledge from these sections.

Wildlife managers must be able to inventory and evaluate an area as habitat for various wildlife species. They must be able to explain the condition of the area and identify the wildlife present to landowners and other interested individuals. Once the inventory and evaluation are completed, managers recommend the appropriate wildlife management practices to enhance habitat for certain wildlife species. **On-site Recommendation of Wildlife Management Practices** (Activity II) provides experience in this decision-making process. The **Written Wildlife Management Plan** (Activity III-A) and **Oral Reasons for the Written Plan** (Activity III-B) should explain management recommendations so others can understand and consider them.

About the Manual

This manual is divided into the following major sections.

WHEP Activities and Scoring provides information on each activity, how the activities are administered, and how the national contest is scored.

Wildlife Management Concepts and Terms introduces basic wildlife management principles. These concepts and terms are the basis for the remainder of the manual. Participants should be prepared to use the wildlife management concepts and terms in their written plan and oral presentation as appropriate.

Ecoregions identifies areas of the U.S. with distinctly different vegetation communities and wildlife species. This section gives a brief description of the vegetation and land use found in the ecoregions, explains typical stages of plant succession, lists wildlife species that may be considered in the national contest and summarizes wildlife management practices that can be used in each ecoregion.

Wildlife Species provides general information about the various species included, as well as the biology, habitat requirements, and wildlife management practices used for the various species.

Wildlife Management Practices explains each of the wildlife management practices discussed in the **Wildlife Species** section.

Appendix A provides definitions of food groups for various wildlife species.

Appendix B is the **Glossary**, which defines technical words used in the manual.

How to Use the Manual

Leaders and participants should first learn the concepts and terms. Then, locate and mark materials pertinent for a particular ecoregion.

Determine which ecoregion will be used for a local, state, or national contest. Maps and ecoregion descriptions are in the Ecoregions section. The **Wetlands** and **Urban** descriptions are applicable to all ecoregions.

Determine which wildlife species will be used. A list of species accompanies each ecoregion. There are many field guides and websites provided by state wildlife agencies and Extension professionals that provide photos and additional information for these wildlife species.

Locate and mark the selected species in the Wildlife Species section. It is important to be able to identify species from different sources and be able to identify the male, female, adult, and juvenile of a species. Learning life history information about a species is critical to make appropriate management decisions.

Locate and mark the appropriate practices in the Wildlife Management Practices Section. Learning how various wildlife management practices affect wildlife species is critical. Note that not all wildlife management practices listed in the manual are used in every ecoregion. The **Wildlife Challenge** (Activity I) may require information from various portions of the manual, including **Wildlife Species**, **Wildlife Management Practices**, **Concepts and Terms**, and the ecoregion of the contest (including **Urban** and **Wetlands**).

Preparing for Contests

Participants should read and understand the **Concepts and Terms** section of the manual. Leaders should explain the concepts and terms and provide local examples to clarify any misunderstanding. This section is important because the activities require understanding of these concepts and terms. Students should use these terms and concepts in their oral reasons portion of Activity III during the contest.

Once the concepts are understood, leaders should review the appropriate regional information with participants. Leaders have the flexibility to use any of the information from the **Ecoregions** section they believe is appropriate. Leaders and participants should review plant succession, common plant species, wildlife species and wildlife management practices. Specific information about habitat requirements and recommended wildlife management practices are found in the **Wildlife Species** section. Many teams/participants find it helpful to mark those species included in the ecoregion they are judging so the information is more easily found when studying.

Leaders can introduce participants to the contest activities through various exercises. Some make note cards or flash cards to help when studying. Conducting practice sessions at outdoor sites is helpful. Participants should get outside and find examples of the principles and practices discussed in this manual. Habitat requirements available for the species selected should be identified, as well as what features are missing. Leaders may use "quiz bowls" and question-answer sessions to measure learning. Field guides and other teaching materials may be used to further learning. The National WHEP website (www.whep.org), state wildlife agencies, state Extension wildlife specialists, and county Extension offices have information regarding the availability of learning materials. Collecting pictures or specimens of the species from several different sources will help when preparing for Activity I.

Local and state events may use different wildlife species and activities from those recommended in the manual. However, at the national event, all activities and only the wildlife species and wildlife management practices listed in this manual will be used.

Beginning and young participants should not be expected to perform all the activities. Organizers of local and state events may limit activities for junior or junior high division participants. Written management plans and oral reasons may not be appropriate for this age group. Participants in the national event will be expected to perform all of the activities in this manual.

General Rules and Guidelines

The national event will comply with all policies and guidelines for national 4-H competitive events.

I. Contestants and eligibility:

A. Each state is allowed to enter only one 4-H team and/or one FFA team. A team will consist of no less than three and no more than four official entrants who are 4-H or FFA members in their state during the current year. If a state is unable to assemble a team, it may send up to two 4-H individual contestants and/or two FFA individual contestants to participate in individual events only.

B. **Contestants must have already passed their 14th birthday, and may not have reached their 19th birthday as of January 1 of the year of the Invitational.**

C. An individual or team may participate in the National 4-H WHEP Invitational event only once during his/her 4-H or FFA career. A team (or individual) may not compete as a 4-H team (or individual) one year, then come back another year as an FFA team (or individual).

D. The team of contestants must be certified as the official state entry by the state Extension or FFA director, or by a person designated by the director. The individuals or team may be selected by any procedure a state considers appropriate. It is required that each state obtain medical authorizations for participants and accompanying adults.

E. If a participant has an Individual Education Plan, a copy of the IEP and any special accommodations must accompany the official entry for the team. Once the IEP and accommodations are received, they will be reviewed. The National WHEP Committee will make all reasonable efforts to accommodate participants with IEPs.

Contestants in the National 4-H WHEP Invitational must **not** have taken classes or participated in official post-secondary (university, college, junior college, or technical school) competitive events of a similar nature in the same subject matter area. Neither can participants be a member of a post-secondary team undergoing training in preparation for an event. For example, a contestant who has competed in an official collegiate wildlife contest, on or off campus, or taken college courses related to natural resources is ineligible to compete in the National 4-H WHEP Invitational. The state 4-H program leaders are responsible for determining the eligibility for participants in national 4-H competitive events from their respective states.

II. General contest rules and information:

The date, location, and ecoregion for the National Invitational will be announced no later than May 1.

A. State team entries must be submitted through the official entry process.

B. Each team can have no more than two adults serving as coaches or chaperones accompanying the team to the invitational.

C. Although there will be educational opportunities before the contest begins, all contestants should study this manual and be prepared before coming to the national event. Questions will not be allowed during the contest except for those related to contest procedure.

D. A materials packet to supplement this manual may be available for leaders and participants in advance of the national event. The packet may contain information on the ecoregion and wildlife species used in the upcoming event. The materials packet will be supplied by the Extension wildlife specialist, 4-H office, or other qualified personnel from the state hosting the national event.

E. Contestants will be required to adhere to the host state's Code of Conduct. No alcohol, tobacco, or drug use will be allowed during the event.

F. Contestants and coaches/chaperones are required to take part in all phases of the National Invitational, including the opening ceremony, educational program, contest, fun activities, coaches tour, and awards banquet.

On contest day:

A. All contestants must provide their own pencil and clipboard. However, no storage clipboards are allowed.

B. No electronic devices of any kind are allowed at the contest site. This includes, but is not limited to, cell phones and iPods/mp3 players. No backpacks are allowed. Bags for medical reasons should be discussed with the National WHEP Committee before contest day. On the morning just prior to the contest, each coach/agent must provide claim to the National WHEP Committee that they have obtained any and all cell phones of contest participants. If a contestant is seen with a cell phone during the contest, that person and team may be disqualified immediately.

C. Contestants will work independently on the individual activities. No talking by contestants will be allowed during the individual activities.

D. Anyone caught cheating will be disqualified at the discretion of the National WHEP Committee.

E. All adults, except contest officials, will be separated from contestants at all times while the contest is in progress. All adults must participate in the designated coaches' activity during contest day.

F. The National WHEP committee will score the contest and analyze results. Their decision is final. After the event, individual and team scores will be made available to the teams. Contest score sheets, management plans, and sketches will **not** be distributed after the contest.

G. The team score will be the sum of the three highest scores in the individual activities, plus the team score for the management plan, which will include the top three scores for oral reasons.

H. Distribution of awards is determined by the state host. However, every National Invitational will recognize the following for both 4-H and FFA:

Team awards
First Place
Second Place
Third Place
NOTE: If there are less than 4 teams competing, awards may be limited to the winning team only.

Individual awards
First Place Individual
Second Place Individual
Third Place Individual
NOTE: Individual awards will be determined by Activities I and II.

WHEP Activities and Scoring

The National WHEP Invitational comprises 3 activities:

Activity I: Wildlife Challenge
Activity II: On-site Recommendation of Wildlife Management Practices
Activity III-A: Written Wildlife Management Plan
Activity III-B: Oral Reasons for Wildlife Management Plan

These activities may be used as presented, or they may be modified as deemed appropriate for local, regional, or state contests.

Individual Activities

Activities I, II, and III-B will be scored on an individual basis. However, awards for top individuals will be based on the sum of scores from Activity I and Activity II only. Individual scores for Activity III-B do not contribute to the top individual score because each participant gives oral reasons to a different judge.

The top three individual scores within a team for Activities I, II, and III-B will count toward the total overall team score. For teams of four members, the lowest score for each activity will be dropped. For teams of three members, all scores will count.

Activity I: Wildlife Challenge (50 points)

Activity II: On-Site Recommendation of Wildlife Management Practices (50 points)

In case of ties for top individuals (summation of Activities I and II), scores for Activity II (WMPs), then Activity I (if necessary), will be used to break ties. If an additional tie-breaker method beyond these is necessary, the National WHEP Committee will determine one.

Team Activity

Activity III will be scored as a team effort and will include scores for Activity III-A and III-B. The written wildlife management plan (Activity III-A) is worth 125 points. Activity III also includes up to 75 points for oral reasons for the written plan (Activity III-B). The maximum score in Activity III-B for each individual is 25 points. Only the top three scores within each team will be counted into the total score for Activity III. Thus, Activity III is worth a maximum of 200 points.

Activity III-A and III-B: Written Wildlife Management Plan and Oral Reasons (200 points)

In the case of ties for the top teams (summation of Activities I, II, and III), summation of the top three individuals in a team for the Activity II score will be used to break the tie. If this does not break the tie, then summation of the top 3 individuals for Activity I will be used to break the tie. If that does not break the tie, then the National WHEP committee will decide the next step to determine the winner.

Activity I: Wildlife Challenge (50 Points)

The ***Wildlife Challenge*** combines wildlife identification and general knowledge. Participants visit stations where they may be presented with a wildlife specimen and questions related to the species. Participants may be asked to identify an animal by specimen or portion of specimen, photo, animal sign, or sound. Alternatively, stations may be located outdoors and questions may be related to various habitat features. Species used in Activity I will be from the ecoregion selected for the contest. Species from ***Wetlands*** and ***Urban*** may be included regardless of ecoregion selected for the contest because there are wetlands and urban areas within all ecoregions. If ***Wetlands*** or ***Urban*** is selected as the ecoregion for the contest, then species from the surrounding ecoregion also may be included in Activity I.

For example, if the Invitational is held in Maine, and ***Northeast Mixed Forest*** is selected as the ecoregion for the contest, then species from ***Northeast Mixed Forest***, ***Wetlands***, and ***Urban*** may be used in Activity I. If the Invitational is held in Maine and ***Wetlands*** is selected as the ecoregion for the contest, then species from ***Wetlands*** and ***Northeast Mixed***

Forest may be used in Activity I.

When identifying species in the **Wildlife Challenge**, the correct spelling and capitalization must be used in order to receive credit. Refer to **Index of Wildlife Species** beginning on page 69 for proper spelling and capitalization.

The objective of Activity I is to demonstrate knowledge of wildlife identification, ecoregions involved, wildlife management concepts, terminology, wildlife management practices, and the biology and ecology of wildlife species. Questions for Activity I may be from information within ***Concepts and Terms, Ecoregions, Wildlife Species, Wildlife Management Practices,*** and the ***Glossary***.

Wildlife food items and questions pertaining to wildlife foods also may be included in the **Wildlife Challenge**. **Appendix A** provides definitions of various wildlife foods. Refer to species accounts to learn what various species eat.

Example questions for Wildlife Challenge:

Specimen at station is a scaled quail.
Name this species. **(scaled quail)**
Is hard mast included in the diet of this species? **(no)**

Specimen at station is a bobcat skull.
This species can be a significant source of mortality for which species?

a) white-tailed deer
b) ruffed grouse
c) wild turkey
d) eastern cottontail
e) northern bobwhite

Station is in the field along a recently disked firebreak.
What is the management feature you are standing in? **(firebreak)**
Which management practice does this feature facilitate? **Set-back Succession (Prescribed Fire)**

Activity II: On-Site Recommendation of Wildlife Management Practices (WMPs)

Activity II involves recommendation of WMPs to manage wildlife on a given site. Species eligible for Activity II only include those listed for the stated ecoregion for the contest. Possible WMPs for each species are shown with an 'X' in the column under each species.

Activity II differs from Activity III in that management recommendations in Activity II should consider each species listed SEPARATELY and WMPs should be recommended as if each species was the only species (focal species) considered on the site. Management recommendations in Activity III consider all the species involved in the plan with concessions considered depending on objectives of the plan, which may include ecosystem management objectives.

Prior to starting Activity II, information will be given about the site (a scenario), either verbally or written (describing field conditions). Based on this information, an 'X' should be marked in the box for each WMP recommended. Contestants will have one hour to complete Activity II. This is an individual activity, so no talking or collaboration among team members is allowed.

Scoring Activity II: Wildlife Management Practices (50 points)

Total Score = [(number of correct answers marked by the contestant minus number of incorrect answers) divided by total number of possible correct answers marked by specialist in charge] multiplied by 50.

The total number of possible correct answers is the number of Xs marked on the card by the specialist(s) in charge. For example, a WMP score sheet key includes 20 correct answers. The contestant marks 15 correct answers, but also marks (or doesn't mark) 5 incorrect answers. The contestant's score is calculated as [(15 – 5 = 10) / 20 = 0.50] X 50 = 25 points.

No negative scores will be assigned. The minimum individual score on Activity II is zero. Blank WMP worksheets for each ecoregion can be found at www.whep.org.

Activity III-A: Written Management Plan (125 Points)

The Written Management Plan is a team event where team members discuss, consider, and provide written recommendations that address current conditions and objectives regarding wildlife populations and habitat on a specified property. A written scenario describing the property, current conditions, and landowner objectives is provided to teams prior to starting the activity. Each team interprets the objectives, identifies the focal species, recommends WMPs and their intended impact, and states how the plan will be evaluated. Species and associated possible WMPs are restricted to those species listed for the ecoregion identified for the contest.

The "Judges' Scoring Sheet – Written Management Plan," shown on page 14, details how plans are judged. All plans must be written using paragraph format. A sample management plan worksheet is provided below to help teams prepare for writing management plans.

Teams will be given four sheets of paper. One sheet is for writing notes. Teams may use **one side** of three sheets for their plan. Two of these sheets are for writing the plan, and the third sheet is for sketching a map of the property illustrating where practices should be implemented. Teams may use pencils only; no pens. Colored pencils are allowed for the sketch if desired. An aerial photo of the area may be provided in place of one blank sheet of paper to assist with the sketch. The team number should be written on the blank back side of each sheet. Plans not written in the proper format or not correctly identified will not be judged. Teams will have two hours to complete this activity.

Example of Written Plan Scenario
2013 National WHEP Written Plan Scenario
Atterbury Fish and Wildlife Area, Trafalgar, Indiana

The Atterbury Fish and Wildlife Area (AFWA) is 6,500 acres and was historically owned by the Department of Defense (DoD, Camp Atterbury) and is now managed by the Indiana Department of Natural Resources (IDNR). Historically, DoD leased fields to local producers for row-cropping, but there were no efforts to manage the area for wildlife. The IDNR has decided to manage particular sections of the property, including the one you are on, for species that use early successional stages, such as eastern cottontail and brown thrasher. The northern bobwhite has been identified as the focal species because bobwhite populations in the ecoregion have declined sharply over the past few decades; therefore, quail hunting has been suspended.

Funding for land management is a limitation. Thus, the IDNR has decided to continue to lease fields for row-cropping, specifically corn, soybeans, and wheat. The IDNR has calculated at least 50 percent of the area must be leased to provide sufficient income for management activities. AFWA is open for hunting. The IDNR foresees hunting opportunities for mourning dove and eastern cottontail, which are relatively common in the area.

The area you are considering is approximately 115 acres and includes 60 acres of soybeans. This section is bordered on the north side by a firebreak and a treeline, on the east side by a firebreak, on the south side by a road, and on the west side by a firebreak and woods.

Your task is to prepare a management plan that provides information and recommendations to meet IDNR's objectives and property limitations. You have 2 hours to complete your plan. This is a team activity. Prepare your plan on 2 sheets of paper, but write only on one side of each sheet. Sketch a map of the area including placement of your management recommendations on the third sheet. Include your **team ID number** on the back of each sheet. Do not write your name or the name of your state on the sheet. Good luck and have fun coming up with your recommendations!

Part I: Plan Background (10 Points)

What are the species to be managed and what are the management objectives?
The species to be managed include northern bobwhite, eastern cottontail, and brown thrasher.
The management objectives are to manage the area for wildlife species that use early successional stages, particularly those listed above, and provide hunting opportunities.

Part II: Plan Development (40 Points)

Species Habitat requirements (20 Points)

Northern bobwhite use scattered patches of shrubby cover, well interspersed with native forbs and grasses. Areas dominated by forbs are commonly used for brooding cover. A variety of seeds, leaves, and insects are eaten.

Eastern cottontails require brushy cover interspersed with herbaceous openings. They eat forbs and grasses, bark of shrubs and young trees, buds, and browse.

Brown thrashers are found in shrub and bramble thickets, brushy hedgerows, young forests, and forest edges. They eat invertebrates and various seeds on the ground among the leaf litter. They usually nest in shrubs up to 10 feet aboveground.

Mourning dove use areas with annual and perennial forbs and grasses with considerable open space at ground level for feeding. They nest in shrubs and trees or on the ground. They commonly use agricultural fields for foraging. They require free-standing water daily.

Habitat Assessment (20 points)

The area under consideration is 115 acres and includes 2 fields of soybeans that have been planted via no-till agriculture that encompass 60 acres. There are field borders surrounding some portions of the soybean fields. There are 2 small woodlots with an open canopy of scattered trees and a dense brushy understory. The remainder of the area contains dense grass (tall fescue) with scattered forbs, brambles, and tree saplings. Brooding cover for northern bobwhite is limited because of a lack of mobility in the thick grass. Brushy cover used for escape and winter loafing by bobwhite is limiting. Cover for brown thrasher only exists in the 2 small woodlots. Cover for eastern cottontail is largely limited to the small woodlots. The tall fescue does not provide overhead cover. Winter cover will be severely limiting for all species after the soybeans are harvested. There is no free-standing water available.

Part III: Plan Implementation (40 Points)

Control Nonnative Invasive Species to reduce coverage of tall fescue and allow the seedbank to germinate, which will provide more food and better cover for all 4 species.
Field Borders should be established around portions of the soybean fields where there are none. This will increase usable space for northern bobwhite and eastern cottontail.
Leave Crop Unharvested will provide soybean seed for northern bobwhite, mourning dove, and eastern cottontail into winter.
Plant Shrubs between sections of soybean fields that will be retained to provide a corridor connecting the two woodlots. Such shrub cover will increase usable space for northern bobwhite, eastern cottontail, and brown thrasher, and increase loafing and nesting cover for mourning dove.
Set-back Succession: Prescribed Fire will rejuvenate the understory in the woodlots and provide more forage for eastern cottontail and northern bobwhite.
Water Development for Wildlife (small pond) should be established to provide free-standing water for mourning doves.
Wildlife Survey should be conducted to monitor populations of all 4 species. Point counts may be used for mourning dove and brown thrasher, covey counts may be used for northern bobwhite, and observation counts and hunter harvest data can be used for eastern cottontail.

Part IV: Plan Evaluation (15 Points)

Wildlife survey data will be evaluated annually and tracked over time to estimate population trends. Hunter success and satisfaction will be accessed through surveys. Vegetation surveys will determine if additional treatment is needed to reduce tall fescue, evaluate success of shrub plantings, and evaluate habitat quality for all species.

Wildlife Habitat Education Program

Judges' Scoring Sheet – Activity III-A Written Wildlife Management Plan

Scale for scoring: 0 = very poor, no points; 10 = outstanding, maximum points

Part I: Plan background (10 points maximum) **_____ points**

- □ Accurately identified the wildlife species to be managed and accurately identified the management objectives

Part II: Plan development (50 points maximum) **_____ points**

- □ Demonstrated understanding of the habitat needs of each species (20 points)
- □ Accurately evaluated the area as habitat for each species (what is present and what is lacking) (20 points)
- □ Identified native plant species or nonnative invasive species (10 points)

Part III: Plan implementation (30 points maximum) **_____ points**

- □ Included the appropriate management practices (10 points)
- □ Demonstrated knowledge of the effect of various management practices on habitat and/or the species (10 points)
- □ Recognized the management compromises necessary to meet the needs of each species and showed understanding of the mutual benefits of implementing certain practices (10 points)

Part IV: Plan evaluation (15 points maximum) **_____ points**

- □ Presented realistic methods for monitoring success of the recommendations (15 points)

Part V: Format and drawing (20 points maximum) **_____ points**

- □ Presented in the appropriate narrative format (10 points)
- □ Included a drawing or sketch of the area, reflecting the recommended management practices and where they should be implemented (10 points)

Activity III-A total (125 points maximum) **_____ points**

Activity III-B:
Oral Reasons for Written Plan (75 points total per team)

After completing the written plan, each team member will be expected to demonstrate their understanding of the plan. Thus, it is important that each team member actively participates in preparing the written plan. Comprehensive knowledge of the written plan is necessary to successfully respond to judges questions about the team's plan. Team members are called individually into a room or outdoor space with one or two judges where they are asked a series of questions to test the individual's knowledge of the team's plan. For example, team members may be asked to explain a certain part of the plan, such as the background or implementation, or they may be asked to further explain certain management practices recommended within the plan. They may be asked to explain the habitat needs of the focal species. Questions can cover anything related to the plan, the focal species, or management practices recommended. Each team member's interview will last 4-5 minutes. The top three scores within each team will be added and combined with the written plan score for the total score for Activity III.

Note: Oral reason scores are not included in determining high individual scores.

Sample questions and requests:

- Explain the WMPs your team implemented for brown thrasher.
- Two of the four species in your plan had very different habitat requirements. Identify those species and explain the compromises you made to accommodate those species.
- The eastern cottontail requires early successional vegetation. Explain the practices your team chose to increase usable space and why they were recommended.
- In assessing habitat for northern bobwhite on this site, what do you consider the most limiting factor?
- Explain two methods you would use to determine the effectiveness of your team's plan.

Wildlife Habitat Education Program

Judges' Scoring Sheet – Activity III-B Oral Reasons for Wildlife Management Plan

Part 1: Subject matter (80 points maximum)
Scale for scoring: 0 = very poor, no points; 20 = outstanding, maximum points

- □ Understanding of species biology and management (0 – 20) _____ **points**
- □ Understanding of species habitat requirements (0 – 20) _____ **points**
- □ Understanding of wildlife management practices and implementation (0 – 20) _____ **points**
- □ Knowledge of concepts and terms (0 – 20) _____ **points**

Part 2: Contestant (20 points maximum)
Scale for scoring: 0 = very poor, no points; 10 = outstanding, maximum points

- □ Logic, reasoning, and organization (0 – 10) _____ **points**
- □ Poise, voice, and body language (0 – 10) _____ **points**

Activity III-B total (25 points maximum) **_____ X 0.25 = _____ points**

Wildlife Management Concepts and Terms

Wildlife management is both art and science that deals with complex interactions in the environment. However, it is critical to understand basic concepts about wildlife ecology and wildlife habitat requirements before management practices can be recommended to enhance habitat and manage populations for a particular wildlife species. Some of the basic concepts are described in this section. WHEP is based on these concepts, so it is important to understand them.

Definitions of various words or terms may be found in the **Glossary** at the back of this manual. Extension Wildlife Specialists, Extension educators, and local state agency wildlife biologists can provide clarification if needed. Additionally, wildlife management textbooks offer more in-depth reading and explanation.

Concepts and terms

- **Species, communities, ecosystems, and landscapes**
- **Plant succession and its influence on wildlife**
- **Habitat and habitat requirements**
- **Species richness and diversity**
- **Nonnative and invasive species**
- **Focal species and ecosystem management**
- **Edge**
- **Arrangement and interspersion**
- **Area-sensitive species**
- **Vertical structure**
- **Carrying capacity**
- **Compensatory and additive mortality**
- **Home range, movements, and migration**
- **Food webs**

Species, communities, ecosystems, and landscapes

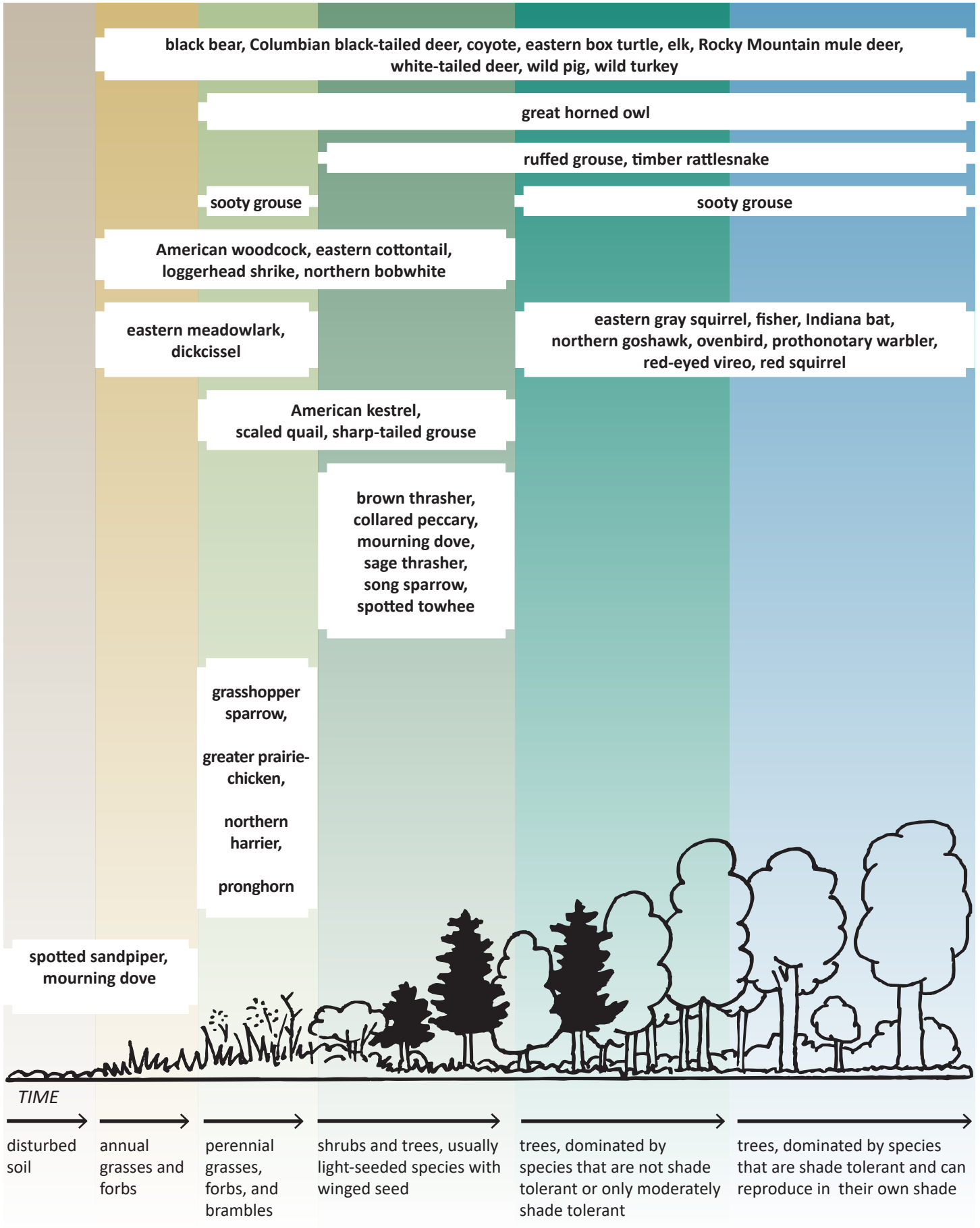
A *species* is a group of individuals that can interbreed and produce viable offspring. A *population* is a group of individuals of the same species interacting and living in a given area. Populations of various species interact to form communities. Therefore, a biotic (living) *community* includes all the plant and animal populations living in a defined area. Communities interact with the abiotic (nonliving) resources (soil, air, water, and sunlight) to form what is known as an *ecosystem*. The size of the area involved when defining communities or ecosystems can vary. For example, the interacting communities of organisms associated with a decaying log or within an ephemeral pond may form an ecosystem. Likewise, this can be expanded to include all the communities associated with a forest ecosystem. The *landscape* is a larger area that composes interacting ecosystems.

Plant succession and its influence on wildlife

Plant succession represents the change in composition of the plant community in a particular area over time. Various plant species that typically occur together represent vegetation types. The sequence of plant communities that are possible and replace one another in progression on a given site is called a *sere*. These various plant communities represent seral stages, which also are commonly called successional stages. Each seral stage, or successional stage, may be represented by many vegetation types, which are indicative of that seral stage.

Climate, soils, and disturbance events determine which plant species (and therefore vegetation types) are found on a particular site. Climate, soils, and disturbance events (such as fire, wind storms, ice storms, flooding) are highly variable; thus, there are many vegetation types that can occur within any of the ecoregions represented in this manual. Examples of vegetation types include an oak-hickory forest; an emergent wetland dominated by cattails, sedges, and smartweeds; a stand of loblolly pine; a grassland dominated by blue grama and buffalograss; a thicket of regenerating aspen; or a fallow field of annual forbs, such as common ragweed, horseweed, and daisy fleabane.

Depending on climate in a particular ecoregion, there may be several or only a few successional stages that compose a sere. For example, in the Eastern Deciduous Forest ecoregion where annual precipitation typically averages 40+ inches, annual grasses and forbs represent the initial successional stage following soil disturbance. Perennial grasses, forbs, and brambles dominate by year 2 or 3 after soil disturbance and represent the second successional stage. Woody species, such as winged sumac, Virginia pine, winged elm, eastern redcedar, and persimmon might become prevalent within 5 or 8 years after disturbance and represent the third successional stage. Various oaks, hickories, yellow-poplar, red maple, blackgum, sourwood, sassafras, and other tree species may pioneer into the site and dominate the area within 20 years, representing the fourth successional stage. Without additional disturbance, such as fire, American beech, white pine, and sugar maple may eventually dominate the forest within 200 years and represent the fifth successional stage. Thus, approximately 5 seral stages (or successional stages) can be expected



This chart is a general representation of ecological succession, depicting how the vegetation community may change over time and how various wildlife species are associated with various successional stages. Various wildlife species from several ecoregions are shown. Keep in mind succession does not advance this far in all ecoregions. For example, succession in the Shortgrass Prairie ecoregion stops with perennial grasses, forbs, and shrubs. Succession in the Hot Desert ecoregion stops with shrubs. Trees in those regions are limited to drainages where water is sufficient to support them.

to compose a sere on many sites within the Eastern Deciduous Forest ecoregion.

One forest type replacing another also is observed in other ecoregions that receive considerable precipitation. For example, Douglas fir forests may be replaced over time by western hemlock in the Pacific Coastal Forest ecoregion. In portions of the Northeast Mixed Forest ecoregion, stands of aspen are eventually replaced by spruce-fir. Development of the later successional stages in a sere is continual, but slow, as one successional stage gradually develops into the next. As a result, the process can be imperceptible to many people. Full development of some seres takes longer than the average lifespan of a human.

Descriptions of the successional process in different ecoregions of the U.S. can be found in the ***Ecoregions*** section of this manual. Successional stages can be difficult to identify or distinguish. Plant identification skills and some knowledge of plant community ecology are helpful.

The final seral stage that a site will transition to in the absence of disturbance is often called the climax seral stage and is dominated by species that can reproduce and replace themselves without additional disturbance. In ecoregions with sufficient rainfall (such as Eastern Deciduous Forest, Southeast and Northeast Mixed Forest, and Pacific Coastal Forest), early successional plant communities ultimately succeed to forests. In drier ecoregions (such as Great Plains Grasslands, Prairie Brushland, and Hot Desert), fewer seral stages compose the sere and vegetation communities of perennial grasses, forbs, shrubs, and cacti may represent the ultimate, or climax, successional stage. Disturbance events, such as fire, grazing, ice, wind storms, and flooding, continually set-back succession and the process starts over.

Although succession is set back through natural disturbances, many natural disturbance events have been disrupted by man. For example, levees have been built to prevent natural flooding, and great effort is expended to suppress and control fire. Also, extensive plantings of nonnative sod-forming grasses have unnaturally altered or interrupted succession in nearly every ecoregion of the country. Because of their dense nature at ground level, the seedbank is suppressed and response (thus succession) is suppressed. Suppressing succession is often called *arrested succession*. There are many nonnative invasive plant species that influence succession in most ecoregions.

Plant succession is an important concept for wildlife managers because as succession takes place vegetation composition and structure (density and height of vegetation) changes, which strongly infuences food and cover available for wildlife. **As vegetation structure and food availability change, the species of wildlife that may be found in an area change because different wildlife species have different food and cover requirements.** All wildlife species are associated with various plant communities or successional stages. Some species, such as wild turkey, white-tailed deer, and coyote, may use several successional stages to meet various life requirements. Others, such as grasshopper sparrow and ovenbird, may be found only in one or two successional stages. The fact that different wildlife species require different successional stages highlights the importance of having a diversity of successional stages if a diversity of wildlife species is a goal or consideration.

The compositional and structural changes of plant communities following disturbance events are fairly predictable within a given ecoregion. Thus, wildlife managers intentionally manage disturbance to provide the appropriate successional stage(s) for various wildlife species or groups of species. Wildlife management practices, such as prescribed burning, forest regeneration, selective herbicide applications, grazing, and disking, can be used in the absence or interruption of natural disturbance events. Alternatively, planting trees and shrubs and lack of disturbance will advance succession.

Differentiating successional stages can be difficult where grasslands, savannas, woodlands, and forests all occur. Grasslands are areas dominated by grasses and other

Plant succession involves a change in plant species composition over time. This field in east Tennessee is moving from the second successional stage (perennial grasses and forbs represented by broomsedge bluestem, goldenrod, and thoroughwort in picture) into the third successional stage (shrubs and pioneering trees, represented by winged sumac, sweetgum, and eastern redcedar in picture).

Oak or pine savannas represent early successional vegetation with scattered trees. However, without continued fire, savannas will succeed into forests.

herbaceous plants (forbs, sedges, and brambles) and few if any trees. Savannas and woodlands are areas with sparse to moderate tree cover and a well-developed groundcover of herbaceous plants. Forests are dominated by tree cover. In areas with abundant precipitation, grasslands, savannas, and woodlands will succeed into forests if not continually disturbed (usually with fire). When evaluating a savanna or woodland in these areas, it is not important to define the successional stage. Instead, evaluation of the structure and composition of the plant community and whether it provides habitat for the wildlife species under consideration is most important.

Habitat and habitat requirements

Habitat represents the physical and biological resources (food, cover, water, space) required by a particular wildlife species for survival and reproduction. Although the general habitat requirements (food, cover, water, space) are required among all wildlife species, the specific resources required among wildlife species may be vastly different. That is, not all wildlife species require the same resources in the same amount or distribution. If those resource requirements are provided in a particular area for a particular wildlife species, then that area represents habitat for that species. Thus, there is no such thing as "suitable habitat"—the area either is or isn't habitat for a particular species. Habitat quality may range from excellent to poor, depending on resource availability, but if the minimum habitat requirements for a given species are not provided, then the area is not considered habitat for that species.

Habitat should not be confused with vegetation or vegetation types, such as a mature hardwood forest or a grassland. Some wildlife species may find all of their habitat requirements within one vegetation type. For example, an eastern gray squirrel may live its entire life within one mature oak-hickory stand. However, other species, such as white-tailed deer and elk, thrive in areas with considerable interspersion of vegetation types. Thus, habitat for these species usually includes several vegetation types and successional stages. Although the term "habitat type" is often used interchangeably with "vegetation type," it is confusing, technically inaccurate, and should be avoided.

Differences in habitat requirements among some species are subtle, whereas differences in habitat requirements among other species are dramatic. For example, habitat requirements for northern bobwhite and American kestrel are somewhat similar. They both require cover dominated by shrubs, forbs, and grasses, but bobwhites primarily eat various plants, seed, mast, and insects, whereas kestrels prey on other animals, including small mammals, lizards, and insects. Thus, even though bobwhites and kestrels may use the same vegetation type or successional stage, their habitat requirements are different. Habitat requirements for eastern gray squirrel and mourning dove are not similar at all. Although they may be found in the same ecoregion, they use different vegetation types and foods and have different space requirements.

Habitat requirements for various wildlife species often change through the year or life stage. Food and cover resources needed during one season or life stage for a particular species may be much different than what is required or available during another. For example, wild turkey hens and their broods spend the night on the ground where there is adequate groundcover until the poults are able to fly. During summer, wild turkey broods often use early successional areas with abundant forbs where they feed upon insects and are hidden from overhead predators. As young wild turkeys reach approximately 2 weeks of age, they roost in trees and shrubs, and as mast becomes available in the fall, wild turkeys are frequently found in mature hardwood forests where available.

Species richness and diversity

Species richness refers to the total number of different species present in an area. Species richness differs from diversity in that diversity not only accounts for the number of species present in an area, but also how those species are distributed and how abundant each species is on that area. One goal in wildlife management may be to

provide habitat for as many different species as possible, as contrasted to managing for a maximum number of individuals within a species or limited number of species. Generally, habitat requirements are provided for more wildlife species when a variety of vegetation types and successional stages are present in an area.

Nonnative and invasive species

Many plants and animals have been introduced, either accidentally or intentionally, into the United States from around the world. These species commonly are referred to as nonnative. Some nonnative species are most useful and have filled a need in our society. For example, wheat (native to southwest Asia) and soybeans (native to northeast China) are two nonnative plants that have provided high-quality foods for both humans and wildlife in the U.S. The domestic cow (ancestors native to Europe and Asia) and chicken (ancestors native to Asia) are examples of nonnative animal species that provide benefit for our society.

Some nonnative species have become naturalized. That is, they are able to maintain populations in the wild. Many of these species have not only become naturalized, but they have become competitive with native plants and animals, sometimes displacing native species. Some naturalized nonnative species are actively managed, such as ring-necked pheasants (native to China), brown trout (native to Europe), wild goats (western Asia), and white clover (native to Europe).

Often, nonnative species are successful because the climate is similar to where they originated and they do not have many natural pests or competitors that may have limited them in their native area. Some nonnative species are so favored by the conditions where they were introduced that they spread at incredible rates and controlling them can be very difficult. These species are both nonnative and invasive. Kudzu (native to Asia), cogongrass (native to southeast Asia), and Japanese stiltgrass (or japangrass, native to eastern Asia) are examples of nonnative invasive plants. Norway rats (native to Asia) and silver carp (native to Asia) are examples of nonnative invasive wildlife and fish.

Nonnative invasive plants contribute to loss of habitat for native wildlife and fish species and can lead to population declines of both native plants and wildlife species. Nonnative invasive wildlife and fish often outcompete native wildlife and fish and cause population declines of native species. Nonnative invasive species (both plants and animals) pose a considerable challenge for natural resource managers. Many nonnative invasive species are extremely difficult to control or eradicate. Herbicide applications, prescribed fire, mechanical removal, and biological control are commonly used to limit the impact of nonnative invasive plants on native plants and animals. Not only do nonnative invasive species impact native wildlife and plants, they also impact agricultural production, water resources, municipal capacity, and even human health and safety. Every effort should be made to prevent the introduction of nonnative species that may become invasive.

Focal species management and ecosystem management

Wildlife management generally is practiced with a focal species approach or an ecosystem management

The ecosystem management approach involves managing for a healthy, functioning ecosystem without focusing specifically on one or more wildlife species. This approach is most often used in an effort to restore imperiled ecosystems on large tracts of land.

Most landowners identify focal species when managing their property for wildlife because not all species benefit from the same wildlife management practices.

approach. The focal species approach involves managing specifically for one or few select wildlife species. The ecosystem management approach involves managing for a healthy and functioning ecosystem, such as the longleaf pine or shortgrass prairie ecosystems, and allowing the associated wildlife species to respond. Most landowners have specific objectives or concerns about a particular species. Once the species is determined, resources that may be limiting (such as cover, food, or water) for that species on that property can be identified and the appropriate wildlife management practices can be prescribed. Occasionally, the focal species may be totally incompatible with the area under consideration and management goals and objectives must be changed.

It is best to select wildlife management practices that provide or improve the habitat requirements most lacking and, thus, are limiting the population (limiting factors). For example, if a species requires trees for cover with water nearby, and the area being evaluated has plenty of trees but no water, a management practice that will supply water will improve the area more effectively than planting trees.

Wildlife management practices that improve habitat for some wildlife species may be detrimental to other wildlife species. It is impossible to manage an area for any one species or group of species without influencing other species in some way. For example, if a mixed hardwood stand is clearcut to benefit ruffed grouse, then wild turkey, white-tailed deer, and eastern cottontail also may benefit. However, species, such as ovenbird, wood thrush, and eastern gray squirrel, which prefer mature deciduous forest, will be forced to use another area.

Edge

An edge is formed where two or more vegetation types or successional stages meet. An obvious example is where a field meets a forest. A less obvious example is where a mature stand of aspen meets a spruce-fur forest. An even less obvious example is where a 40-year-old mixed hardwood stand meets an 80-year-old mixed hardwood stand.

The transition in vegetation types or successional stages can be abrupt or gradual. An example of an abrupt change would be where a hayfield meets mature woods. This type of edge has high contrast and is called a *hard edge*. A more gradual change would be where a 40-year-old forest meets an 80-year-old forest. A much more gradual change is where an overgrown field with native grasses, forbs, and scattered shrubs blends into a brushy thicket or a 3-year-old regenerating hardwood stand. This type of edge has low contrast and is called a *soft edge*. Sometimes the edge or transition between two vegetation types is so gradual, characteristics of both are evident in a relatively wide zone, called an ecotone. A common example of an ecotone is where an upland hardwood stand meets a bottomland hardwood stand. Species transition occurs gradually with the elevation change as the upland blends into the bottomland.

The concept of edge is important in wildlife management. If there is increased edge, then there is increased interspersion of vegetation types or successional stages. This may be beneficial for a particular wildlife species *if*:

- both vegetation types are usable by the species and provide some habitat requirement;
- the arrangement of the vegetation types is suitable for the focal species (see ***Arrangement and interspersion*** on page 23).

The abrupt change in species composition and structure (left) is typical of a hard edge. Allowing native grasses, forbs, and brambles to grow into the field from a woods edge is typical of a soft edge and increases the amount of usable space for many wildlife species by providing suitable cover and food resources.

John Gruchy

For those wildlife species considered "edge" species, the physical edge presented where two vegetation types or successional stages meet is not as important as the actual structure presented within a vegetation type or successional stage.

Some species do not require much space to live. An eastern gray squirrel or eastern box turtle might spend their entire lives on only a few acres. Other species, however, require considerable area. Grasshopper sparrows, for example, are rarely found in grasslands smaller than 100 acres.

Increased interspersion also can lead to increased species diversity, as more vegetation types are available, and can potentially provide habitat requirements for a larger number of species. It is important to realize the presence of edge is not always beneficial for any wildlife species. If the vegetation types or successional stages present do not provide any habitat requirement for the species in question, the interspersion and resulting edge is not beneficial. Thus, looking at an aerial photo and counting the number of times different vegetation types or successional stages meet should not be used to measure of habitat quality for any species. Also, some species may actually avoid edges and seek areas that are more similar.

Furthermore, some species often found along an edge have been relegated to use the edge because the interior of the adjacent vegetation type is unattractive or does not provide any habitat requirement. For example, wild turkey and northern bobwhite broods might be found along the edge of a field dominated by tall fescue or bermudagrass. The reason the birds are not in the interior of field is not because they necessarily like the edge, but because there is not suitable cover or food resources in the field, or the structure of the vegetation in the field is so thick at ground level the birds cannot walk through it. Thus, if the composition and structure of the vegetation in the field was improved to provide mobility and adequate cover for quail and turkeys, there would be as many birds in the opening as along the edge. As a result, there would be additional habitat for the birds and the carrying capacity of the property would be increased (see ***Carrying capacity*** on page 25). In summary, the edge is not what is necessarily important, but rather the composition and structure of the vegetation.

Arrangement and interspersion

How different successional stages or vegetation types are situated in relation to each other is often referred to as arrangement or juxtaposition. Some wildlife species may obtain all of their habitat requirements from only one vegetation type or successional stage (such as crissal thrasher, eastern gray squirrel, gopher tortoise, sharp-tailed grouse, or ovenbird). Other species require (or greatly benefit from) more than one successional stage to provide all their habitat requirements (such as bobcat, northern bobwhite, white-tailed deer, wild turkey, American woodcock). For example, ruffed grouse may forage on acorns in mature mixed-hardwood

The arrangement of vegetation types and successional stages directly influences animal movements and home range size. Here, cover for nesting and brooding, and escape cover are arranged in close proximity (juxtaposed) to favor habitat requirements for northern bobwhite.

stands during fall and winter, but use young forest stands with high tree-stem densities for escape cover. Required successional stages should be close to each other to better allow safe travel to and from those areas. Proximity is especially important for species with limited movements and relatively small home ranges.

Interspersion is the frequency of occurrence of different vegetation types. Increased interspersion generally leads to increased "mixing" of vegetation types and often supports a greater diversity of wildlife. However, the vegetation types present and the quality of cover and food resources present in those vegetation types are more important than whether or not there is much interspersion. As interspersion increases, so does the amount of edge. However, as discussed in ***Edge***, increased interspersion is not necessarily beneficial to all species. Interspersion is easily viewed on aerial photos or satellite images. However, habitat quality cannot necessarily be assessed by viewing aerial photos or satellite images. It is true that where there is increased forest cover, the amount of habitat for eastern gray squirrel likely is increased, and where there is increased grassland cover, the amount of habitat for grasshopper sparrow likely is increased. However, the composition and structure of the vegetation in fields, shrubland, and forests greatly influence habitat quality for many species, and that fine-level analysis is not possible by viewing photos. Thus, walking over the property and taking a closer look is necessary when evaluating habitat for most species.

Area-sensitive species

Fragmentation is the disruption of vegetation types either by man or by natural processes. All wildlife species do not respond to fragmentation the same way. For some, the edge between a young forest and an older forest may fragment their habitat, whereas others may not respond to fragmentation except under extreme circumstances such as an interstate highway bisecting a forest or prairie or suburbia creeping into a rural area. Some species need large, unfragmented areas in a certain successional stage to provide some or all of their habitat requirements. Such species are referred to as area-sensitive. For these species, large areas in one successional stage are desirable. Unfragmented habitat of at least 100 acres is considered the minimum requirement for many area-sensitive species. Some species, such as the grasshopper sparrow, may require a minimum of 1,000 acres of relatively unfragmented habitat to sustain a viable population. Others, such as the greater prairie-chicken, may require 30,000 acres of relatively unfragmented habitat.

The vertical structure in this mature oak/hickory forest provides cover and food resources for a suite of forest songbird species that otherwise would not be found here.

Vertical structure

In most vegetation types, there are distinct layers of vegetation. In a grassland, there is often a litter layer with one or two layers of grasses and forbs. In a forest or woodland, there may be three distinct layers of vegetation. The understory is composed of those plants growing near the ground, up to 4.5 feet tall. The understory may be very diverse and include grasses, forbs, ferns, sedges, brambles, vines, shrubs, and young trees. The midstory is represented primarily by shrubs and trees more than 4.5 feet tall yet below the overstory canopy. The overstory is made up of those trees in the canopy.

How the different layers of vegetation are arranged in relation to each other is important to many wildlife species. For example, some birds require more leaf litter in a grassland than others and some like taller grasses, whereas others prefer shorter grasses. Some birds may require a herbaceous understory for foraging in the forest, but nest in the overstory. Vertical structure may vary dramatically from site to site, even within a given field or forest type. For example, one mature oak-hickory forest might have a well-developed understory and midstory with visibility of no more than 30 feet, whereas another has very little understory vegetation and no midstory at all. Although they are the same forest type, these two forests would not necessarily provide habitat for the same wildlife species. The structure could be manipulated on these sites depending on the objectives. Thinning and prescribed fire are two management practices that are commonly used to influence understory and midstory structure in forests and woodlands.

Any area is only able to support a certain number of animals before available food and cover resources are depleted. Here, overabundant white-tailed deer have exceeded the carrying capacity of the area. Chronic overbrowsing has eliminated the forest understory and thus negatively affected many other wildlife species that require understory vegetation for nesting, feeding, roosting, or escape cover.

Carrying capacity

There are only so many animals that can live in an area. The concept of carrying capacity is related to the number of animals that can exist in an area. Biological carrying capacity refers to the maximum number of animals, within a given species, an area can support before that species or another species is negatively affected. The quantity and quality of food, cover, water, and space determines the carrying capacity. The requirement that is in shortest supply, called the limiting factor, determines carrying capacity. Increasing the requirement in shortest supply can increase the area's biological carrying capacity.

Biological carrying capacity varies from season to season and often from year to year. For most species, it is usually greatest from late spring through fall when food and cover are most abundant. This time of year is when young of most species are born, which helps ensure adequate nutrition and cover are available for growth and survival. With the coming of winter or summer drought, food and cover gradually diminish.

More animals are produced each year than will survive. Surplus animals are lost to predation, starvation, competition, or disease. Young wildlife and animals in poor health experience the highest mortality rates. Hunting and fishing remove some animals and may help prevent over-population for some species (see **Compensatory and additive mortality**).

In suburban areas, humans often demand the density of certain wildlife species be lower than the biological carrying capacity because of wildlife damage issues. For example, white-tailed deer populations can thrive in suburban areas where the biological carrying capacity is relatively high because deer have adapted to feed opportunistically on ornamental plants. However, homeowners generally have low tolerance for deer feeding on expensive landscape plants. Thus, the deer population must be reduced to limit damage. In this case, the cultural carrying capacity (determined by human tolerance) is lower than the biological carrying capacity.

Compensatory and additive mortality

Annual mortality is the rate at which animals die per year. The mortality rate for a species often is estimated by biologists to help determine management efforts for that species. Animals die from many causes, including predation, diseases, malnutrition, weather, hunting, accidents, fighting, and others. All of these factors may contribute to the annual mortality rate for a particular species. For example, each of those factors contributes to the annual mortality rate of white-tailed deer in Minnesota each year. However, the number of deer that die from each of these causes of mortality is not the same, and the number of deer that die from each cause in Minnesota may differ greatly from the number that die from each cause in Tennessee in any given year.

The number of animals that die from one cause of mortality often influences the number that may die from another cause. For example, increased harvest of deer by hunters in October and November leaves fewer animals in the population that winter. Thus, more food is available per animal and the likelihood of deer dying from starvation decreases. Thus, mortality from hunting and mortality from malnutrition can act in a compensatory manner. As the mortality from one cause is increased, the mortality rate of another is decreased. To relate this to the WHEP contest, ***Increase Harvest*** may be recommended to lower white-tailed deer populations so that food availability is increased per animal and fewer animals are susceptible to winter starvation.

Mortality can be additive. For example, rainfall commonly influences northern bobwhite populations in portions of Texas and Oklahoma. In years with little rainfall, there is less groundcover to provide cover and food and, as a result, fewer quail survive through summer and fall. Thus, the bobwhite population going into winter may be quite low because of malnutrition, predation, and heat stress through the summer. If the population is at a critically low level, additional mortality from hunting through winter may be *additive*, especially if hunting pressure is equal to

that in normal years. As related to WHEP contests, if the population of a nonmigratory game species has declined for some reason and is considered too low to sustain the level of mortality experienced recently by regulated hunting or trapping, ***Decrease Harvest*** may be warranted.

Hunting is not the only mortality factor that could be additive. Using the scenario above with relatively few bobwhites surviving through summer and fall, there still may be sufficient numbers of quail to replenish the population when the breeding season begins. However, a late winter storm that dumps unusually deep snow and persists for a while can limit food availability even further. Thus, more quail die. In this situation, mortality is *additive* from the snowfall. Regardless of whether the population was high or low, a significantly high percentage of the population would have been affected by the weather event.

Thus, it is important for biologists to monitor mortality rates for various species, especially those that are hunted, and be prepared to adjust regulations and management practices to better manage for a particular species. Adjusting regulations and management practices as conditions change and additional information becomes available is termed *adaptive management*.

Home range, movements, migration, and corridors

A home range encompasses the area in which an animal lives. Home range size is related to habitat quality. Daily movements include those for normal day-to-day activities. In higher-quality habitat, home ranges tend to be smaller than in lower-quality habitat because movements necessary to meet life requirements are reduced. A seasonal home range is the area an animal uses in a particular season of the year. A seasonal movement, or migration, is made when an animal moves from one seasonal home range to another. Migration may represent movements to and from wintering and nesting areas (such as waterfowl and songbirds) or wintering and calving areas (for caribou and some elk populations). Migration also can involve movements from higher elevations to lower elevations each spring and fall as food availability varies with the seasons (seen with elk and some species of grouse).

Migration distances may be short or very long, depending on the species. Long migrations for some species require habitat along the route (to stop and rest and eat). Thus, wildlife managers must consider this in landscape planning for various species, which means habitat conditions might have to be considered across states, countries, or even continents.

Corridors are areas that do not restrict movement and allow various wildlife species to move from areas within their home range or during migration. The type of vegetation within the corridor and the size (both width and length) of the corridor needed varies depending on the species. An example of a corridor might include a stream or river with trees and shrubs along both sides (the riparian zone) cutting through a large grassland. The wooded, riparian corridor facilitates movement for squirrels, deer, wild turkey, and other species that require or otherwise seek the security of wooded cover to cross a broad open area. A smaller version of such a corridor would be a hedgerow traversing a large field. Other examples of corridors might include valleys between mountain ranges for migrating mule deer, or underpasses facilitating black bear movement under interstates and major highways.

Food chains and food webs

Food chains are the step-by-step passage of material and energy (food) through an ecosystem. A network of interconnected food chains is called a food web. In terrestrial ecosystems, plants are primary producers in a food chain because they supply food at the lowest level of the food chain. In aquatic ecosystems, phytoplankton (microscopic algae) is the base of the food chain. It takes an enormous number of individual plants (or amount of phytoplankton) to support the other parts of a food web. At the next level of a food chain are primary consumers, plant-eating animals or herbivores. Primary consumers include rabbits, mice, deer, and certain other mammals; some insects and fish; and dabbling ducks, geese,

Alan Windham

Predators, such as this red-tailed hawk, are necessary to buffer populations of various prey species. For most predators, when one prey species begins to decline, other prey species become more prevalent in the diet.

and various other bird species. In aquatic ecosystems, zooplankton and aquatic insects feed on phytoplankton.

Primary consumers are eaten by secondary consumers, or carnivores (meat-eaters). This group includes predators, such as birds of prey, snakes, foxes, cats, and people. In aquatic ecosystems, zooplankton and aquatic insects are eaten by small fish. Small fish are eaten by larger fish. Secondary consumers are eaten by tertiary consumers, which may be predators or scavengers, such as turkey vultures, crabs, and sometimes people. Note these categories are very broad and general. Many animals fit into more than one group, and there are more complex levels of a food web. An example is an omnivore, which is an animal that eats both plant and animal matter.

Any of the food web components mentioned above can be broken down by decomposers—organisms such as bacteria and fungi that reduce dead plant or animal matter into smaller particles. A decaying plant, for example, will be broken down into nutrients that enrich the soil. This process supports the growth of more plants and thus, more animals.