Biological Opinion
on the U.S. Army Maneuver Center of Excellence
at Fort Benning, Georgia

Prepared by:
U.S. Fish and Wildlife Service
Georgia Field Office
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List of Acronyms/ Abbreviations

Act- Endangered Species Act of 1973
ACUB- Army Compatible Use Buffer
AMF- Army Modular Force
AP3- Army Power Projection Platform
AR- Army Regulation
ARC- Army Reconnaissance Course
BA- Biological assessment
BFV- Bradley Fighting Vehicles
BNCOC- Basic Noncommissioned Officer Course
BO- Biological Opinion
BOLC- Basic Officers Leader Courses
BRAC- Base Realignment and Closure Act of 2005
CFR- Code of Federal Regulation
DA- Department of the Army
DBH- Diameter at breast height
DMPRC- Digital Multi-purpose Range Complex
DOD- U.S. Department of Defense
DPW- Department of Public Works
Eagle Act- Bald and Golden Eagle Protection Act
EIS- Environmental Impact Statement
EMD- Environmental Management Division
EPA- Environmental Protection Agency
ERDC- Engineer Research and Development Center
ESA- Ecological Society of America
ESMP- Endangered Species Management Plan
FB Form 144-R- Fort Benning "Record of Environmental Consideration"
FB- Fort Benning
FBCB- Fort Benning Conservation Branch
FBLMB- Fort Benning Land Management Branch
FBRD- Ft. Benning Range Division
FHA- Foraging habitat analysis
Ft. Benning- Fort Benning
FTX- Field training exercise
FY- Fiscal Year
GADNR- Georgia Department of Natural Resources
GDRP- Global Defense Posture Realignment
GIS- Geographic Information Systems
GPCA- Georgia Plant Conservation Alliance
GQFH- Good Quality Foraging Habitat
GTA- Grow the Army
GWOT- Global War on Terrorism
HBCT- Heavy Brigade Combat Team
HMA- Habitat management areas
HMMWV- High-Mobility Multipurpose Wheeled Vehicle

IBCT- Infantry Brigade Combat Team
ID/IQ- Indefinite delivery/indefinite quantity
Inc.- Incorporated
ITAM- Integrated Training and Management
ITS- Incidental take statement
JCA- Dr. J.H. Carter III and Associates, Inc.
LIDAR- Light Detection and Ranging
LRAM- Land Rehabilitation and Maintenance
MCOE- Maneuver Center of Excellence
MOU- Memorandum of Understanding
MSS- Managed Sustainability Standard
NCOA- Noncommissioned Officer Academy
NEPA- National Environmental Policy Act
NPDES- National Pollution Discharge Elimination System
NRCS- Natural Resources Conservation Service
Oscar Complex- Oscar Small Arms Complex
OSUT- One-Station Unit Training
PBG- Potential breeding groups
Pers. Comm.- Personal Communication
PRC- Primary recruitment clusters
PVA- Population viability analysis
RCW- Red-cockaded Woodpecker
RDP- Range Development Plan
RFMSS- Range Facility Management Support System
ROD- Record of Decision
RPA- Reasonable and prudent alternatives
RS- Recovery Standard
RSLC- Reconnaissance and Surveillance Leaders Course
RTLP- Range Training and Land Program
SBCT- Stryker Brigade Combat Team
SCDNR- South Carolina Department of Natural Resources
SDZ- Surface Danger Zone
SEPM- spatially explicit, individual-based population model
SERPPAS-Southeast Regional Partnership for Planning and Sustainability
SLC – Scout Leaders Course
SRC- Supplemental recruitment clusters
SRP- Sustainable Range Program
SRTC- Southern Range Translocation Cooperative
STX- Situational training exercise
Take- Incidental Take
TNC- The Nature Conservancy
TRAP- Training Resources Arbitration Panel
UAV- Unmanned aerial vehicle
US- United States
USAARMC/S- US Army Armor Center and School
USACE- U.S. Army Corps of Engineers

USAIC/S- US Army Infantry Center and School
USDI- U. S. Department of the Interior
USFS- U.S. Forest Service
USFWS- U.S. Fish and Wildlife Service

United States Department of the Interior

FISH AND WILDLIFE SERVICE
1875 Century Boulevard
Atlanta, Georgia 30345

In Reply Refer To:
FWS/R4/ES

MAY 29 2009

Colonel Thomas MacDonald
Garrison Commander
Department of the Army
Headquarters United States Army Infantry Center
Ft. Benning, Georgia 31905-5000

FWS Log No: 2009-FA-0118

Dear Colonel MacDonald:

This document is the U.S. Fish and Wildlife Service's (Service or USFWS) biological opinion (BO) based on our review of the October 27, 2008, biological assessment (BA) for the construction, operation and maintenance of proposed Maneuver Center of Excellence (MCOE) actions, which include Base Realignment and Closure, Army Modular Force, Global Defense Posture and Realignment, Grow the Army, Global War on Terrorism, and Army Power Projection Platform, located in Chattahoochee and Muscogee Counties, Georgia, and Russell County, Alabama, and the expected effects on the federally-endangered red-cockaded woodpecker (RCW, *Picoides borealis*) and federally-endangered relict trillium (*Trillium reliquum*) in accordance with section 7 of the Endangered Species Act (Act) of 1973, as amended (16 U.S.C. 1531 et seq.). Your request for formal consultation was received on November 4, 2008. Our November 10, 2008, response notified you of our intent to proceed with formal consultation on these two species. The Service received information from the Army regarding project effects throughout consultation; however, major updates were provided on March 9 and 23, and May 4, 2009.

This BO also utilizes information provided in the December 12, 2008, Draft Environmental Impact Statement; meetings, modeling exercises, telephone calls, field investigations, electronic mail, and published and unpublished sources of information. A complete administrative record of this consultation is on file at our Fort Benning (Ft. Benning or Installation) office.

Consultation History

October 1, 2007 through February 29, 2008.

- Service personnel were notified that approximately 39 new projects were being proposed under a MCOE project. Service personnel attended the MCOE "kick-off" meeting on January 22 and 23 to discuss the proposed action, and to listen to strategies that were being proposed by the Installation to decrease the impacts to RCWs and their habitat.

- The Service's Southeast Regional Director discussed MCOE concerns with the Army's Deputy Assistant Secretary for the Environment.

- Service personnel attended several technical meetings and participated in many conference calls throughout this time period collaborating and advising Ft. Benning leadership, Department of Defense (DoD) representatives, and Army staff on issues regarding the anticipated effects from the MCOE proposal.

March 1, 2008 through July 31, 2008.

- Service personnel attended a MCOE Environmental Impact Statement (EIS) scoping meeting held in Columbus, Georgia.

- The Service's Regional Director discussed MCOE concerns with regional representatives from the Army Corps of Engineers (ACOE); specifically, the ACOE's Brigadier General for the Region and the Director of Military and Civil Programs for the Region. Also in attendance was the Environmental Protection Agency's (EPA) Regional Administrator.

- Service staff coordinated and facilitated a workshop, held on Ft. Benning, with a small group of RCW experts. The group was asked to explore the potential impacts the MCOE projects might have on the Installation's RCW population. The discussion focused primarily on RCW demography and viability. The group concluded that a population demographic model should be used to better predict how the Installation's RCW population might respond to the MCOE impacts.

- Service personnel attended several Army Compatible Use Buffer Program (ACUB) meetings to explore the usefulness of off-site properties as a means to satisfy potential environmental off-sets for the Installation. Primarily, the strategies were focused on RCW off-sets.

- Service personnel participated in Southeast Regional Partnership for Planning and Sustainability (SERPPAS)/RCW Technical Working Group at Fort McPherson in Atlanta, Georgia, to discuss MCOE effects on RCWs.

- Service staff met with Ft. Benning personnel and suggested that two separate RCW population viability models (e.g., Walters and Bruggeman) were available to assess the potential effects of the MCOE proposal.

- Service's Southeast Regional Director met with the Army's Deputy Assistant Director to discuss potential effects from MCOE.

- Service staff participated in several conference calls over this time period, generally providing technical assistance on section 7 questions, but also discussing the effects of the MCOE proposal on the RCW population, and helping to explore some potential conservation strategies that might be used to abate the proposed MCOE impacts.

August 1, 2008 through December 31, 2008.

- Service personnel participated in a conference call with Army representatives to discuss potential conservation issues related to MCOE and were advised that the next iteration of the MCOE Draft BA would be delivered for review during the first week of August of 2008. Army staff reported, however, that the draft would have little information on any potential minimization strategies, and that the document would not detail any potential impacts that might occur from military training activities.

- The Service received the Draft MCOE BA on August 6, 2008. The Army asked that at a minimum, the Service review specific portions of the BA to include sections on the proposed action, impacts assessment, and the adverse effects analysis. Once reviewed, the Army asked to have the comments back by no later than August 14, 2008.

- August 13, 2008, the Service returned its comments on the review of the Draft BA. The review comments focused mostly on pages 477 thru 485, and two maps on pages 474 and 475. The Service was asked if the document, in its current form, provided an appropriate level of assessment for RCW impacts. As part of the comments and response, the Service responded negatively and suggested that additional analysis would be needed.

- September 9, 2008, the Service reviewed another iteration of the Draft MCOE BA and responded with another set of comments.

- The Service was informed by the Ft. Benning Conservation Branch (FBCB) that Dr. Jeffery Walters of Virginia Technical University, and Dr. Timothy Hayden of the ACOE would be willing to run their population viability models in support of the MCOE BA process.

- The Service received comments from the Installation on the second Draft MCOE BA review. The Installation questioned whether some or merely a specific portion of, the Service questions could be addressed. The Army suggested that answering some of the questions would require "substantive rewrites which would compromise their project timeline." The Service responded by stating that any of the questions provided by the Service were discretionary. However, if left unanswered, it's possible that there could be circumstances in which the Service might have to draw critical inferences based on limited information provided.

- Service staff was invited, by the Army, to attend an ACUB meeting in Atlanta, Georgia. The groups in attendance included the Georgia Department of Natural Resources (GADNR), The Nature Conservancy (TNC), and various representatives from the Army. The discussions focused primarily on forming land protection partnerships between the Army, TNC and the GADNR. The partnership would focus on securing lands, using various land protection mechanisms (e.g., easements, fee simple acquisition, etc), as a means to reduce MCOE impacts on the Installation's RCW population.

- Service staff participated in a meeting to evaluate the MCOE project. The group of eight included two representatives from the Installation's Training Directorate, two from the Environmental Directorate, two from the Army's Installation Management Command and two from the Service.

- October 1, 2008, Service staff attended a MCOE update meeting that included an extensive briefing by the Installation's Range Training Directorate. The trainers described the construction process needed to plan and build the MCOE proposed infrastructure, and described the operational training requirements recruits would need to master in order to graduate from the Armor School. The trainers also stated that if the BO turned out to be unfavorable, they would consider removing projects as a reasonable and prudent alternative to remove a jeopardy determination. They suggested that for Transformation/BRAC initiatives, which would include the MCOE proposal, ranges and maneuver corridors were discretionary.

- October 10, 2008, the Service received notice that the 3rd Draft BA was available for review,-and that the return date for comments was October 14, 2008.

- Service staff participated in several meetings and conference calls to discuss the most recent iteration of the Draft BA, and to discuss various components of the Walters and Hayden RCW demographic/population viability models.

- The Service received the final MCOE BA on November 4, 2008, with the request to initiate formal consultation.

- November 10, 2008, the Service provided comments on the final MCOE BA, and stated that as of this date, formal consultation was initiated.

- The Service received data from the Walters and Hayden model runs. A meeting was held on December 9, 2008, to discuss both models. Dr. Walters and Dr. Hayden were available to answer questions that representatives from the Army and the Service had regarding the model assumptions, outputs, potential future runs, etc.

- Service personnel met with the Ft. Benning Garrison Commander on December 18, 2008, to discuss their early assessment of the MCOE impacts to RCWs. Service staff emphasized the poor health of the Installation forest and the vulnerable conditions the impact of the MCOE would exacerbate.

January 1, 2009 through May 4, 2009.

- January 12, 2009, Service personnel advised the Garrison Commander that preliminary analyses indicated a jeopardy determination would be warranted, and the timeline of formal consultation prompted expedient resolution of outstanding issues including development of a reasonable and prudent alternative, if necessary.

- January 27, 2009, the Service forwarded to Ft. Benning a request for a 60-day extension of time to prepare the biological opinion. We noted that the Army would be able to use the additional time to develop project alternatives.

- January 30, 2009, Ft. Benning staff briefed the Service on the current plan to access and manage existing RCW groups in the A20 Impact Area. Currently, only a portion (14 of ± 60) of the A20 groups are managed. The majority of the A20 groups is currently subject to adverse training effects and included in an incidental take statement (USFWS 2002). As such, the protected groups cannot be counted toward the recovery goal. The Service advised the Army that whatever the total number of groups the Army proposes to apply toward their recovery goal, they must be able to meet the minimum requirements for RCW management.

- February 3, 2009, the Service and Ft. Benning discuss modeling and programming concerns with Dr. Doug Bruggeman of Virginia Tech University. Dr. Bruggeman has used and modified a version of the Walters demographic model.

- February 4, 2009, Ft. Benning and Service representatives continued discussions regarding modeling options, data collection and data needs for the upcoming modeling workshop.

- February 5, 2009, Service personnel advised Ft. Benning that the modeling effort was likely not going to provide useful information due to the limitations of the model.

- February 6, 2009, Service personnel were advised by Ft. Benning that the modeling workshop would happen as planned.

- February 9, 2009, Ft. Benning hosted the kick-off workshop for running the spatially explicit RCW demographic model

- From February 10 to 13, 17 and 20, 2009, briefings were held to discuss, evaluate and observe the outputs derived from the spatially-explicit model runs.

- February 13, 2009, the Garrison Commander provided via electronic mail his agreement to extend formal consultation by 30 days.

- February 25, 2009, the Garrison Commander and Service participated in a conference call to discuss reasonable and prudent alternatives for the MCOE proposal, including migration of mechanized training off-base.

- March 2, 2009, Army staff informed the Service that the road project that would impact the Randall Creek North relict trillium population had been relocated such that only a small portion of the northern tip of the population would be directly affected.

- March 9, 2009, Army provided the Service with four updated sections of the biological assessment.

- March 10, 2009, Army advised the Service the remainder of the updated information would be provided on March 23, 2009.

- March 12, 2009, the Service received a request from the Army to move the relict trillium stems potentially affected by the MCOE prior to the completion of the consultation.

- March 13, 2009, the Service received a partial update of the MCOE biological assessment and asked the Garrison Commander, via electronic mail, for an additional 30 days for consultation.

- March 15, 2009, the Service advised the Army to mark the relict trillium stems to facilitate their move once consultation is completed.

- March 23, 2009, Army forwarded to the Service approximately 600 pages of updated information on the MCOE project.

- March 24, 2009, Army advised the Service that a portion of the relict trillium site included in the consultation had been inadvertently destroyed and updated information would be provided.

- March 27, 2009, Army and Service staff had a conference call to discuss issues related to managing RCW groups in the A20 impact area, and a potential reasonable and prudent alternative. Army was provided draft text on the RPA and agreed to supply details that would be acceptable to them. Army advised that additional information regarding the RPA and trillium update would be delivered by close of business March 30.

- March 30, 2009, Army and Service staff had a conference call to discuss available reasonable and prudent alternatives. Options for migrating training off the Installation and option for managing RCW groups in the A20 impact area were discussed. The Garrison Commander agreed that management of 40 groups was a priority.

- April 10, 2009, the Service advised the Garrison Commander that the draft biological opinion would soon be forwarded to them; however, likely changes to the proposed action and RPA were creating a less defensible solution for avoiding a jeopardy determination.

- April 12, 2009, the Garrison Commander advised the Service of tornado damage to RCW clusters.

- April 13, 2009, Army and Service staff had a conference call to discuss status of tornado salvage operations. The group also discussed accessibility issues related to potential management of clusters in the A20 impact area; in particular, safety concerns related to UXOs is a problem for on-foot access to many parts of the impact area.

- April 14, 2009, Army and Service staff had a conference call to provide updated information on tornado salvage operations and the expected indirect effects of the proposed action. The Army originally estimated 55 clusters would be indirectly impacted by training but failed to adjust the number once they had assessed direct impacts. Most of the 55 clusters, 31, would be directly impacted due to, for example, habitat impacts. As a result, the revised number of clusters indirectly affected by training due to the MCOE is 24. The Army also explained they are continuing to refine projects to minimize adverse effects.

- April 15, 2009, the Service forwarded the draft biological opinion to the Army for review.

- April 15, 2009, Army acknowledged receipt of draft opinion and accepted the Service's request to provide the final opinion 10 working days after receipt of Army's comments on the draft. Army requested a joint meeting for April 20.

- April 17, 2009, Army and Service staff had a conference call to discuss the details of the RPA to avoid jeopardy, including accessing clusters in the A20 impact area and mechanized training that would and would not be migrated off-post. A meeting was scheduled for April 21 at Ft. Benning to jointly write the RPA. The conference call was followed up with an email from the Service to the Army asking logistical questions about A20 access.

- April 21 and 22, 2009, Army and Service staff met to discuss and write the RPA for the proposed MCOE.

- April 23, 2009, Army and Service staff shared edits, via email, of the jointly-written RPA.

- April 23, 2009, Army advised the Service that the aerial survey of the Kilo impact area confirmed a connecting dispersal corridor from the clusters in the northeast corner of the Installation to the nearest clusters to the southwest.

- April 24, 2009, Army advised the Service of their agreement regarding the RPA language.

- May 4, 2009, Army provided the Service with 100+ pages of input regarding the draft biological opinion.

- May 5, 2009, the Service acknowledged receipt of the Army's input regarding the draft biological opinion.

BIOLOGICAL OPINION

This section of the document provides a description of the action, an overview of the action area, a listing of the species that have been included in the BO, and a summary of relevant biological and ecological information on the species included in the BO.

DESCRIPTION OF THE PROPOSED ACTION

Background

The Ft. Benning Military Installation, located in Chattahoochee and Muscogee Counties, Georgia and Russell County, Alabama, is currently undergoing major changes in its organizational structure. The actions proposed for this MCOE BO include projects that have changed since the evaluation in a previous USFWS BO (USFWS 2007) for BRAC 2005 and Transformation actions (BRAC) at Ft. Benning, and additional actions that are requested to support increased training demands of the MCOE. The MCOE is scheduled to be established in October 2009 from the consolidation of the US Army Armor Center and School (USAARMC/S) and the U.S. Army Infantry Center and School (USAIC/S) at Ft. Benning to meet the requirements of the BRAC decision to move the USAARMC/S to Ft. Benning. Additional actions proposed to support the MCOE include new Transformation projects not previously evaluated and actions necessary for Grow the Army (GTA) and Global War on Terrorism (GWOT) initiatives.

In November 2007, the Army announced its decision to implement the BRAC 2005 and Transformation actions at Ft. Benning in a Record of Decision (ROD) U.S. Army Corps of Engineers (USACE 2007a). These actions included projects and training area uses that were funded, programmed and/or planned through Fiscal Year (FY) 2013, and that supported BRAC, Army Transformation, Army Modular Force (AMF), Global Defense Posture Realignment (GDPR) and Army Regulation (AR) 5-10 stationing initiatives. Collectively, these actions are referred to in this document as Ft. Benning "BRAC."

The most substantial impact of the BRAC proposal is the movement of the USAARMC/S from Fort Knox, Kentucky to Ft. Benning. BRAC projects that were identified as reasonably foreseeable into FY14, but were neither funded nor programmed when the environmental documents were being completed, were not evaluated in the BRAC BA (USACE 2007b) or the Service's BRAC BO (USFWS 2007) and were only evaluated in the BRAC FEIS for cumulative effects (USACE 2007c). Since the BRAC BO (USFWS 2007), some of these projects have been funded, programmed and/or planned to support the MCOE and, therefore, need to be analyzed.

New construction and training needs have also been identified for the MCOE due to an increase in personnel and students associated with GTA and GWOT. In 2007, the Army announced its decision to increase its overall size while continuing to restructure its forces in accordance with modular Transformation decisions (USACE 2007a). The impacts of this growth were analyzed in the Programmatic EIS for GTA and Force Structure Realignment (USACE 2007c); however, impacts to species listed by the Service as federally endangered or threatened ("federally-listed species" or "listed species") need to be assessed in a BO at the Installation level.

Under the proposed action, the Army proposes 16 projects (10 BRAC, 1 AMF and 5 "Non-BRAC") originally identified in the BRAC BO (USFWS 2007a) that have changed locations and/or have expanded and are being reassessed. As funding sources and projects have changed, the 16 projects have now been split into 18 projects, 17 of which are now considered to be BRAC-directed. One project that was classified as "Non-BRAC" in the BRAC BO is now classified as an Army Power Projection Platform (AP3) project.

The overarching need for the proposed action is for Ft. Benning to: 1) adjust construction of projects evaluated in the BRAC BA, 2) to ensure the complete stand-up of the MCOE, and 3) to provide sufficient operation facilities, training areas (including ranges and maneuver areas) and infrastructure to accommodate the increased military personnel and students due to Army Growth and the GWOT.

Action Area

For the purpose of consultation under section 7 of the Act, the "action area" is defined at 50 CFR 402 to mean "all areas affected directly or indirectly by the Federal action, and not merely the immediate area involved in the action." For projects impacting RCWs, the action area must include the RCW "neighborhood," which is defined by a buffer extending beyond the directly impacted area(s) equal to the average dispersal distance of RCWs within that RCW population or subpopulation (USFWS 2005). Dispersal is defined as the movement of individuals from their natal cluster to their first breeding location, or between consecutive breeding locations (USFWS 2003). For this BO, dispersal distance was defined as the average distance Ft. Benning RCWs have traveled from their natal cluster to find an available niche, or between consecutive breeding locations. This included birds that were part of a breeding pair, helpers to an unrelated breeding pair and solitary birds defending a vacant territory (USACE 2008). Ft. Benning RCW dispersal data collected over 11 years was analyzed by FBCB and revealed an average dispersal distance of 2.57 miles (USACE 2008). This buffer was applied to all active RCW clusters impacted by the proposed action. In addition, if not already included in the RCW neighborhood, the area encompassed by the RCW survey area was also included.

The action area, including the Installation and affected adjacent lands is 216,748 acres. The portion of the action area outside of the Installation boundary, but within the RCW neighborhood, includes portions of Chattahoochee, Marion, Muscogee and Talbot Counties, Georgia, and Russell County, Alabama (Figure 1; see Appendix A for all figures). This action area also encompasses effects to the relict trillium which will affect one population along Randall Creek within the Installation boundary.

Project Description

The action under consideration is a blend of new projects and projects that were once part of the BRAC project consulted on in 2007. The new construction and additional training is a result of several Army directives and initiatives briefly described here.

Army Power Projection Platform

One reanalyzed project, the rail loading facility expansion will support Ft. Benning's Army Power Projection Platform (AP3) mission.

BRAC-Directed, New

The new BRAC-directed projects in the proposed action support the movement of the USAARMS to Ft. Benning. These projects are predominantly in the training areas and include two modified record fire ranges, a fire and movement range, and an anti-armor tracking and live-fire complex. One project covers infrastructure in the northern maneuver area. Additionally, several construction projects in the cantonment area are planned. A multi-purpose training range was also proposed for the northeast corner of the Installation but has since been deleted from project plans. The existing Hasting Range will be utilized instead.

Army Modular Force (AMF)

The Multi Purpose Machine Gun 2 Range was reanalyzed as part of the proposed action.

Global Defense Posture Realignment (GDPR)

In the BRAC environmental documents, GDPR actions were limited to personnel realignment increases. These personnel would be stationed either within existing facilities or accommodated in one of the new facilities being built in support of BRAC, AMF or other stationing actions. There is one new GDPR project that is part of the proposed action, the Unit Maintenance Facilities.

Grow the Army (GTA) and Global War on Terror (GWOT)

Six new projects have been identified to accommodate GTA at Ft. Benning, all of which are in cantonment areas. One GWOT project is proposed for construction on the Main Post.

Personnel Increases

Additional personnel are expected to support recent and current initiatives. Approximately 8,357 students are expected to relocate to Ft. Benning as a result of BRAC actions, and the GTA plan includes an additional 118 permanent troops at Ft. Benning. GTA will also include an additional 35,000-soldier temporary increase across the Army at a rate of 7,000 soldiers per year between 2008 and 2012. At Ft. Benning, this growth primarily translates into increased student numbers at the Armor and Infantry Schools, Basic Officers Leader Courses (BOLC), Officer Candidate School and Army Airborne School (USACE 2008). The proposed GTA projects will support one additional Initial Entry Training Battalion at Ft. Benning which equates to 120 cadre members and up to 1,200 soldiers per day (5 Companies with 240 soldiers per Company).

Training loads have increased in the Infantry One-Station Unit Training (OSUT) courses and is expected to increase to meet Training Resources Arbitration Panel (TRAP) requirements. The OSUT starts are scheduled for FY09. Training loads of the Basic Combat Training Brigade have also increased as a result of the temporary personnel increase. Ultimately, two additional Basic Combat Training Battalions with 5 to 7 Companies each are expected. Currently, there are 43 classes scheduled for this year, which is an increase from the 32 classes/year outlined in the Range Development Plan (RDP).

Construction Projects

Carrying out the requirements of the proposed action will involve constructing new facilities and renovating/upgrading existing facilities and infrastructure, construction of, and modifications to, ranges and training areas and increasing the use of live-fire training ranges and maneuver areas.

There are four primary cantonment areas on the Installation. These are the areas where infrastructure facilities on the Installation are typically concentrated; however, many of the proposed projects fall outside of these areas as traditionally defined. All non-range projects located in the general cantonment area are divided into four broad areas using the applicable cantonment area names: 1) Harmony Church, 2) Kelley Hill, 3) Main Post, and 4) Sand Hill. These broader analysis areas may contain projects not typically considered cantonment projects, such as the vehicle recovery course. Likewise, infrastructure projects that are located within range areas are listed within the appropriate geographic area.

Training areas are grouped into five general regions: Northern ranges (training areas northeast of Hwy. 27-280 and west of Lorraine Rd.), Oscar Small Arms Complex (Oscar Complex), Northeastern ranges (training areas northeast of Hwy. 27-280 and east of Lorraine Rd.), Southern Maneuver Area, and Southern ranges (all training areas southwest of Hwy. 27-280) (Figure 2).

Limits of disturbance for several projects overlapped and the same area could be disturbed for adjacent projects. Acreages presented represent the maximum area disturbed by each project. Therefore, the sum of all acreages is greater than the total acreage potentially disturbed by MCOE projects. Acreages of separate parts of the same project (e.g., a range footprint, limits of construction and beaten area) do not overlap. The area analyzed for any individual project may not equal the maximum area disturbed for that project. Table 1 is a summary of projects included in the MCOE including reanalyzed BRAC projects (see Appendix B for all tables).

Training Area Roads

The limits of disturbance for all proposed roads and trails were originally analyzed at 96 ft. from the centerline (or 192 ft. wide) to provide room for berms and erosion control measures, and to provide for flexibility in design, with the exception of where limits of disturbance were constricted to avoid or minimize impacts to environmental resources. Once roads or trails are established, it is expected that the average width will be 30 ft. including berms, and will support the variety of wheeled and tracked vehicles (M1A1 Tanks to High-Mobility Multipurpose Wheeled Vehicle (HMMWVs)) used for USAARMS training. The average disturbance with will be 60 ft. The erosion control measures are outlined in Soil Erosion Control Plan discussed under "Measures to Reduce Direct and Indirect Effects of the Proposed Action."

Maneuver Training

Maneuver training at Ft. Benning will increase from 25,246 sq mile days to 67,951 sq mile days (area X number of iterations X days per iteration X number of units) upon implementation of BRAC actions: a 149% increase (USACE 2006). Due to personnel increases described below, however, an additional 1,922 sq mile days are now needed for one USAARMS training course, bringing the total heavy maneuver requirement up to 69,873 sq miles, a 156% net increase with BRAC and MCOE.

Training units of the USAARMS relocating to Ft. Benning include the 194th Armored Brigade, the 16th Cavalry Regiment and the Army Noncommissioned Officer Academy (NCOA). Together, these units are responsible for training every Armor Crewman in the Army and Marines. More than 70 training courses currently conducted at Fort Knox, ranging in length from 1 to 20 weeks, will be shifted to Ft. Benning as part of MCOE (USACE 2007b).

Example training courses anticipated to take place in the Maneuver Areas are discussed below:

The 194th Armored Brigade's 19th Delta One Station Unit Training Cavalry Scout (19D OSUT) course trains initial entry Cavalry Scouts in small arms; Bradley Fighting Vehicles (BFV), HMMWV and Stryker mechanics; use of simulators; gunnery; dismounted combat orienteering; mounted and dismounted urban operations; driver training and includes a field training exercise (FTX). Ten days of training will be in the field and the course will be conducted 23 times per year. Cavalry Scouts are trained to operate BFVs, HMMWVs and Strykers at the basic and advanced drivers training courses and also conduct live fire training at small arms and stationary gunnery ranges; the remainder of the FTX will be conducted within the 19D/K OSUT Maneuver Area. Approximately 40 vehicles, including BFVs, HMMWVs and Strykers, are used during this course, but students rotate between the ranges and driver training course. Up to 14 vehicles are typically present in any given area.

The 194th Armored Brigade also conducts the 19K OSUT Armor Crewman (19K OSUT) course, which trains armor crewmen in the same aspects as above with M1A1 Abrams tanks, HMMWVs and Strykers. This course involves approximately 55 of the above-listed vehicles. The field training for this course lasts 9 days and is conducted 13 times a year. As with the 19D OSUT, the vehicles are dispersed between the ranges and the Driver Training Course and generally stay in single-file lines and/or small formations. Armor crewmen will be trained to operate M1A1 Abrams, HMMWVs and Strykers at the basic and advanced drivers training courses and also conduct live fire training at small arms and stationary gunnery ranges; the remainder of the FTX will be conducted within the 19D/K OSUT Maneuver Area.

The NCOA is responsible for conducting both the 19D Basic Noncommissioned Officer Course (BNCOC) Cavalry Scout (19D BNCOC) and the 19K BNCOC Armor Crewman (19K BNCOC) courses. These are similar to the 19D and K OSUT courses described above and each include 3-day FTXs conducted 12 times a year. This frequency has increased from the five times a year that was analyzed in the BRAC BO (USFWS 2007a).

The 16th Cavalry Regiment's Scout Leaders Course (SLC) currently being taught at the USAARMS is being revised to become the Army Reconnaissance Course (ARC). This course is designed to train and educate platoon leaders, platoon sergeants and section sergeants to effectively lead a reconnaissance platoon. This will be a 10-day course conducted 11 times a year, which is a significant increase in length from that analyzed in the BRAC BO (4-day course, 11 times a year) (USFWS 2007). Student loads in this course have roughly tripled to 120-160 students/class (USACE 2008) since the BRAC BO (USFWS 2007a) in order to support AMF and GTA initiatives. Instead of being strictly a USAARMS course, it will now be available to all students with a reconnaissance mission. This course will initially be taught at Fort Knox; however, the increased student loads assessed in this document will not be funded until 2011, when the USAARMS will be at Ft. Benning (USACE 2008). Some of the student load of the Reconnaissance and Surveillance Leaders Course (RSLC), currently taught at Ft. Benning by the 4th Ranger Training Brigade, will transfer to the ARC. Therefore, training loads of the RSLC will be reduced.

The ARC will be conducted in the Southern Maneuver Area. This course includes a 3-day situational training exercise (STX) where students will be trained in unmanned aerial vehicle (UAV) operations, land navigation and reconnaissance mission preparation. During a 7-day FTX, three teams each comprised of 30 students and 10-18 trainers will act as an Infantry Brigade Combat Team (IBCT), Heavy Brigade Combat Team (HBCT) and a Stryker Brigade Combat Team (SBCT). Each iteration of the FTX will evaluate 120-160 students. During the FTXs, there will be approximately 185 personnel (including 120-160 students), 13 tracked vehicles, 8 Strykers, and 38 other wheeled vehicles spread throughout the Southern Maneuver Area.

The largest-scale FTXs at USAARMS will be during the Basic Officer Leader Course (BOLC) III, which will involve approximately 4 BFVs, 16 M1A1 tanks and 33 HMMWVs. This course includes 8-day FTXs which will occur 11 times per year. Exercises during the FTXs will typically involve 4 tank platoons and 3 reconnaissance platoons and will train Soldiers in conducting full-on attacks, defense, convoy escorts, route clearance, various reconnaissance missions, quick reaction force, dismounted infiltration, and urban reconnaissance and raids. During the FTX, co-use of the area by other units and/or civilian personnel is possible, but limited (USACE 2008). The BOLC III also includes 2-4 day STXs conducted 11 times per year. The total of all time spent in the field per course will be 23 days.

As part of their ongoing effort to maximize resources and efficiency, as well as minimize environmental impacts, the Army is also developing an initiative termed "Ground School XXI." This program establishes training strategies that employ combinations of live, virtual and constructive simulations to train future soldiers, leaders, commanders and staff in conducting operations. The desired end state for this initiative is, through simulation, to provide the MCOE and the Army with the capability to train and rehearse operations across the full spectrum of conflict for both mounted and dismounted operations (USACE 2008). These and other courses range in extent and duration; and are listed in Table 2.

<u>Maneuver Training Areas</u>
Ft. Benning has approximately 84,925 acres of designated heavy maneuver training area, including the addition of the Good Hope Maneuver Area evaluated in the BRAC BO and ROD (USFWS 2007; USACE 2007a) and excluding restricted areas. For clarification, this total area is referred to as "heavy maneuver land." The current and proposed heavy maneuver area use is depicted in Figure 3. Once existing and approved future Transformation range Surface Danger Zones (SDZs) (post-BRAC) are subtracted, approximately 64,560 acres remain for heavy maneuver training. The areas currently designated as heavy maneuver will not change under the proposed MCOE action. However, due to increased throughput demands and as a result of additional training analyses, training impacts in these areas have increased or changed substantially, and additional maneuver space and infrastructure is needed.

Ft. Benning has designated four smaller areas and/or corridors within the heavy maneuver land for the most frequent, concentrated or intense off-road use by the USAARMS, collectively referred to as "maneuver areas." These will be the areas that experience substantial impacts to the existing flora and fauna. While these sites will be the primary areas for off-road heavy maneuver training, other types of training will also occur.

Heavy maneuver training within the maneuver areas, but outside of the maneuver heavy use areas, will stay greater than or equal to 50 ft. from all RCW cavity trees and otherwise adhere to the applicable Army RCW Guidelines (USDOA 1996, 2007). Off-road heavy maneuver acreages do not include the 50-ft. buffer around each cavity tree. Off-road heavy maneuver impacts will occur within corridors referred to as the "maneuver heavy use areas" (USACE 2007b).

Measures to Reduce Direct and Indirect Effects of the Proposed Action

Project Design

Ft. Benning personnel reviewed each adverse effect expected from the proposed action to determine minimization measures that could be taken. As consultation progressed, engineers reduced the limits of disturbance for most roads and trails, and some segments were eliminated. Line-of-sight (line of sight or LOS) analyses were conducted for each range during design and to assist biologists in calculating munitions impacts to downrange habitat and determining where to focus minimization efforts (e.g., placement of environmental berms or shifting of targets).

All RCW cavity trees will be screened to prevent RCWs use at the time of cutting. In clusters where RCWs can be translocated, all cavities will be screened immediately after RCWs are captured and removed. Cavity trees that are cut will be either destroyed onsite or collected for educational purposes with appropriate permitting from the Georgia Department of Natural Resources and the Service. Active cavity trees will not be cut during the nesting season (April-July).

Berming of Small Arms Ranges

As BRAC and MCOE small arms ranges have reached 60 to 100% design, Fort Benning Range Division (FBRD) conducted LOS analyses to determine which forested areas may be impacted by ordnance. The impacted forested area located down-range of a range footprint is referred to as the "beaten area." Using GIS, by examining the location and extent of the beaten areas in relation to RCW habitat, the FBCB and FBRD were able to evaluate the need for berms.

Translocation

The RCW Translocation Plan (Ft. Benning 2007) will be updated or a new Plan will be written to incorporate needs stemming from the proposed action. Ft. Benning will consult with the Service to determine where those RCWs should be relocated. If intrapopulation translocation is preferred (depending on habitat availability and distance from the impacted cluster to the recruitment cluster), Fort Benning Land Management Branch (FBLMB) and FBCB will ensure that the recipient clusters are in the best condition possible via thinning, hardwood midstory control and/or cavity installation and maintenance. Necessary stand improvements will be completed prior to the translocation event. Groups may also need to be translocated from clusters within maneuver heavy use areas and range beaten areas. FBCB will consult with the Service if monitoring indicates that translocation is necessary.

The Ft. Benning National Environmental Policy Act (NEPA) Process

Every action with a potential environmental effect (e.g., training exercises, timber operations, construction) must be preceded by the submission of a completed Ft. Benning Form FB144-R to the Environmental Management Division (EMD) Department of Public Works (DPW). Submittal of the Form FB 144-R constitutes the first step in NEPA compliance at Ft. Benning, and also is used to evaluate and monitor Act compliance. The proponent of an action must clearly identify the purpose of, and need for, the action and submit the FB Form 144-R in time to identify problems and conflicts in order that a review and analysis of alternative sites, or altered operational plans, can be developed in time to support the proposed action. The normal "shelf life" of a FB Form 144-R is one year from the date of approval. FB Form 144-R for all actions that are not underway within this time period must be submitted for an updated review and approval.

Non-compliance with this NEPA process will result in the proponent of the action violating Federal law and Army policies. The proponent is held responsible for adverse impacts to Ft. Benning's natural or cultural resources and may be responsible for the cost of repair, replacement or mitigation required to correct the unapproved action. Violations are reported as appropriate to the FBRD, EMD, the Office of the Staff Judge Advocate, the Contracting Officer and/or the proponent's Commanding Officer. Criminal violations of the Act are also reported and investigated per Army policy.

With regard to the Act, the Form 144-R process addresses a scope of effects that would document the Army's determination of no effect to listed species. Where effects are likely, the process prompts the Army to coordinate with the Service to assess whether informal or formal consultation is appropriate. The form also prompts the Army to coordinate with the Service regarding any compliance issues associated with listed species. All BRAC and MCOE projects will continue to be approved using the process described above to ensure compliance with Act and the terms of the applicable BOs. If environmental impacts differ from those approved in the applicable BO, the appropriate level of consultation (formal or informal) with the Service will be reinitiated.

Timber Harvesting and Management

Many MCOE construction projects will be design-build, which means the final design will not be complete until after contract award. Once the contract is awarded and the contractor has finalized the design, the construction contractor will survey and mark the clearing limits for construction. FBLMB personnel will mark the areas to be clear-cut in support of construction. FBLMB and/or the Army Corps of Engineers (USACE) Resident Forester will monitor timber operations for compliance with Georgia forestry BMPs for water quality, streamside management zones, and timber/vegetation removal. In clear-cut areas, all merchantable/saleable trees greater than or equal to 5 inches dbh and greater than or equal to 30 ft. tall or larger will be removed within the red painted boundary (USACE 2008).

RCW Cavity Tree Protection (wildfire response)

Ft. Benning staff is responsible for protecting all RCW cavity trees that are counted toward their recovery goal. Once an event occurs, wildfire response procedures are generally determined by the potential effects the fire may have on various resources. In effect, the Installation burn boss or fire crew determines if priority resources could be negatively impacted. If RCW cavity trees are vulnerable to wildfire, and military troops are in the area, fire crew members either stop the training until the fire is out or work around training until the fire is out. If wildfire occurs in dudded impact areas, typically the fires are left to burn because some of the RCW clusters in impact areas are unsafe for fire suppression actions, and therefore are included in an incidental take statement (e.g., impacts associated with the Endangered Species Management Plan).

The A20 Impact Area is made up of roughly a 10,000-acre dudded impact area. The area has thousands of acres of longleaf pine and contains Ft. Benning's highest density of RCWs. However, the majority of groups occupying the area are not counted toward the Installation's recovery objective. The area is used for training and is under a surface area safety zone for the majority of the year. The area also has significant safety concerns due to unexploded ordnance that litters the area. The A20 area currently has 14 clusters that are managed; three of them are counted toward the Ft. Benning recovery goal. In 2008 and 2009, additional surveys of the A20 impacts area added 32 clusters to those previously known (39) (total is 71 clusters, 65 active). Ft. Benning is proposing to count 61 clusters towards recovery, but only intends to manage 22.

Thinning Within Maneuver Heavy Use Areas

The FBLMB will coordinate with the Armor School trainers for thinning of heavy maneuver areas. Sensitive areas (e.g., wetlands, eligible historic properties that have not been fully mitigated) will not be harvested to aid in protection from heavy training maneuvers. FBLMB and/or the USACE resident forester will monitor timber harvesting for compliance with Georgia forestry BMPs.

Other Standards and Normal Activities to Occur Before and During Timber Harvest Activities

Soil disturbance will be minimized in wetlands (except where permitted in construction areas) and historic property sites. Cut-to-length will be the only authorized process used for timber harvest from eligible historic property sites and other sensitive areas that may be identified later.

If the harvest is performed by a USACE contract, the USACE resident forester will monitor the timber harvest and prepare a biweekly written report to the FBLMB chief. These reports will document compliance with all applicable minimization and/or mitigation requirements and/or restrictions, including compliance with forestry BMPs, any deviations from the same, and any corrective action that was taken.

FBCB personnel will conduct a RCW survey of all project footprints and all suitable habitat within a 0.5-mile radius of any project that may impact RCW cavity trees and/or habitat as per guidelines in the 2003 Recovery Plan (USFWS 2003). All surveys will be conducted within one year prior to habitat clearing or timber harvest. If surveys are more than one year old, FBCB will re-survey the area to ensure that this guideline is met. In addition, a RCW foraging habitat analysis (FHA) will be conducted prior to removal of pine habitat. Timber harvesting within RCW clusters will occur outside of the breeding season (April-July) and will be coordinated with FBCB.

The Army will reinitiate formal or informal consultation with the Service if during field surveys and/or analyses, additional project impacts are identified that were not analyzed.

Total Land Management Strategy

The combination of the proposed increase in heavy maneuver training and the terrain and soil conditions at Ft. Benning has the potential to create major soil erosion problems, which could have adverse effects on the RCW and other federally-listed threatened and endangered species if not mitigated.

Avoidance and minimization of impacts to RCWs will be accomplished by a combination of institutional and engineering controls and the programming of adequate funds necessary to proactively manage the impacts of the proposed actions. Ft. Benning has developed a management system and plan along with the appropriate organizational structure to proactively manage the impacts of training activities, which will be continued and/or enhanced for the proposed MCOE actions. One key function of this strategy is to attain resources for land maintenance personnel to effectively respond to issues. Soil erosion can escalate quickly and can cause substantial damage to the landscape if not repaired.

The Land Rehabilitation and Maintenance (LRAM) component of the Integrated Training and Management (ITAM) program is the Army's program for land rehabilitation, restoration, maintenance, and sustainment of training lands. Currently the only source for repair is the USDA Natural Resources Conservation Service (NRCS). Range Division is in the process of establishing an indefinite delivery/indefinite quantity (ID/IQ) contract for land rehabilitation and repair to provide another vehicle so more projects may be completed in a shorter period of time. Range Division is also looking into the establishment of in-house maintenance capability in order to respond rapidly to the heavily used areas in order to maintain the areas in a safe and usable condition.

Future erosion control measures include the installation of nine turn pads in the Southern Maneuver Area, 20 water crossings in the 19D/K OSUT Maneuver Area, and 39 water crossings and 43 turn pads in the Good Hope Maneuver Area as part of military construction program in FY09. A series of strategically-located sedimentation basins supported by the BMPs and including rock rip-rap, vegetation, and diversions are being designed for each of the maneuver areas to minimize erosion.

As per the BRAC BO (USFWS 2007), Reasonable and Prudent Measure #3 states that Ft. Benning must "Develop the Installation's Land Management Plan that focuses on the Soil Conservation Program and Sustainable Ranges." Further, Term and Condition #3 states that the "Land Management Plan" should include: organizational structure that can support this initiative, strategies to abate significant training impacts in highly erodible soils, a management system with protocols that specify areas to rotate to when erosion impacts breach thresholds in the proposed maneuver areas, and specific roles and protocols for ITAM and how the Range Training and Land Program (RTLP) will be implemented. This plan must be completed no later than November 30, 2009.

Components of the total land management strategy include the following:

Elimination System (NPDES) Permit and Soil Erosion Control Plan

The Soil Conservation Program addresses erosion and sedimentation in RCW habitat as required by the BO for the RCW ESMP (USFWS 2002) and the BO for BRAC (USFWS 2007). The

ESMP BO requires Ft. Benning to repair existing, and prevent future, erosion that threatens individual RCW cavity trees and the integrity of the cluster. BMPs employed to prevent erosion and rehabilitate eroded areas include the construction and maintenance of rock channels, rock check dams, sediment basins, diversions and silt fencing. Vegetative measures include temporary and permanent grassing, mulching and the installation of erosion control blankets. Longleaf pines are planted to further stabilize the project sites and to provide habitat for the RCW. These practices are part of erosion control plans implemented by the NRCS through a Memorandum of Understanding (MOU) and the USACE (a MOU with the USACE is not necessary since it is part of the Army). Additionally, these practices are in line with those outlined in the Georgia erosion and sediment control manual (GSWCC 2001).

Construction projects or any land disturbing projects larger than one acre also require a NPDES permit, which requires a Soil Erosion and Pollution Control Plan. These plans utilize BMPs to reduce erosion and sedimentation. Variances may be required for disturbance or vegetation removal within the stream buffers.

The ITAM Program has funded NRCS to prepare a watershed protection plan for the Good Hope Maneuver Area, the Southern Maneuver Area and the Northern Maneuver Area. This plan is currently being drafted. The watershed protection plan and the BMPs that include strategically placed sedimentation basins, rip-rap, and vegetation are designed to be installed after construction is complete and will augment those erosion control measures such as the low water crossings and turn pads being installed during construction.

Sustainable Range Program (SRP)

The SRP is the Army's roadmap for how it designs, manages and uses its ranges in order to ensure the capability, availability, and accessibility of its ranges to meet its training mission. It is the Army's response to the increasing challenges brought about by incompatible land uses and meeting the ever increasing need for ranges and training land brought about by the GWOT, the Army Campaign Plan, BRAC, and GDPR. Because many programs and functions affect the management of the ranges and training lands, the SRP is the Army's overarching guidance for integrating operational, training, facility, safety, and environmental requirements to improve the management of its ranges and ensure their sustainability to support mission requirements now and into the future. The Army's SRP is made up of two core programs: the RTLP, which includes the day-to-day management of its ranges as well as new range construction and the ITAM program for the repair and maintenance of its maneuver lands.

Ongoing and Future Activities to Conserve Listed Species

Management of Groups Affected by the Proposed Action

Clusters which are adversely affected because of insufficient post-project foraging habitat will retain the same level of protection they currently have. Painted bands on cavity trees will not be removed from primary recruitment clusters (PRCs) and the 1996 Armywide Guidelines will apply within the 200 ft. and 50 ft. buffers (USDOA 1996). If, over time, these groups survive, are productive and acclimated to the training disturbance and/or reduced foraging habitat that triggered the adverse effect, Ft. Benning can formally request from the Service that those clusters be counted again towards Ft. Benning's recovery and population goals. In addition, for clusters identified as adversely affected due to habitat loss, but that do not actually fall below the Managed for Sustainability Standard (MSS) due to alterations in the final design plan; Ft. Benning will request their inclusion toward the population's recovery goal. The MSS is the Service's standard (USFWS 2003) for the minimum quantity and quality of RCW foraging habitat to avoid adverse effects and incidental take (e.g., harm).

Clusters that contained sufficient suitable and potentially suitable habitat combined were not considered lost at the RCW foraging partition level. Instead, efforts will be conducted to improve the potentially suitable stands so that they are suitable, such as suppressing hardwood midstory and thinning overstory hardwoods and/or pines less than or equal to 10 inches dbh. Improved habitat quality may contribute to increased cluster stability and group reproductive output.

Continuing to protect and monitor the clusters that are adversely affected by MCOE projects will allow Ft. Benning to track the status of those clusters into the future. With the Service's approval, clusters that fall below the MSS standards, but remain active for five consecutive years, may be counted towards Ft. Benning's recovery goal. Any taken RCW clusters that remain active can play a role in increasing (or maintaining) cluster density and population health, maintenance of demographic connectivity, and continue to contribute fledglings for overall population stability and growth. To minimize adverse effects in areas where two or more adjacent clusters were eliminated due to loss of foraging habitat, the remaining habitat was reallocated and clusters were repartitioned. Ft. Benning will continue to manage clusters not expected to meet the recovery standard. Continued management of these clusters/partitions may result in the perpetuation or reformation of adversely affected groups and allow these sites to be counted towards the Installation population goal.

Ft. Benning will improve potentially suitable stands that were included in foraging habitat totals to prevent adverse effects. Each stand requiring management will be visited by FBLMB personnel to determine a management strategy. Treatment methods will include harvest of stands that are overstocked with trees and too dense for RCWs, where applicable, for merchantable timber removal (pine or hardwood) and herbicide applications (broadcast and hack/squirt) for non-merchantable hardwood control. Stands with a sparse overstory (generally less than or equal to 40 ft^2/acres in pines greater than or equal to 10 inches dbh) may then be under-planted with longleaf pine that, with future growth and age, will restore RCW habitat. Habitat improvement will be conducted prior to the initiation of clearing for the first project impacting the cluster in question. Where applicable, entire compartments will be reviewed for timber management prescriptions for efficiency purposes, but in other cases only identified stands will be treated. Where time constraints exist, only those portions of the identified stands that fall within the foraging partition will be improved or only the minimum improvement required to bring the cluster up to the MSS standards will be conducted prior to project initiation. When time permits, the remaining acreage will be improved. Although only stands greater than or equal to 30 years old were counted towards foraging habitat, stands greater than or equal to 25 years were included in the list of stands for management, with the rationale that with management, these stands could be valuable foraging habitat during or soon after project construction.

Environmental Awareness Training and Programs

Since 1999, an Environmental Awareness Training Program has been in place to instruct Ft. Benning personnel about environmental issues, to prevent environmental incidents and to protect personnel from financial and legal consequences of such actions. Education is targeted towards personnel with specific responsibilities: one course is targeted toward senior leadership, the executive officer of a brigade or battalion-sized unit, while others may be targeted to the supervisory field personnel or to entire groups of visiting soldiers. Due to the high influx of personnel expected with the USAARMS arrival, it is possible that these courses will be taught at Fort Knox prior to a unit's arrival at Ft. Benning. If not, the courses will be offered more often at Ft. Benning to ensure adequate and timely training of the newly arrived troops. Training guidelines and restrictions within RCW clusters have also been included in Ft. Benning's Training Directive (USAIC Regulation 350-1) and Range and Terrain Regulation (USAIC Regulation 210-4) (USDOA 2001, 2005).

Ongoing Research

Several studies are currently being conducted at Ft. Benning on longleaf and loblolly pine decline. These studies are in response to recent observations (since 2000) of Installation-wide reductions in pine vigor and elevated pine mortality rates. The loss of individual trees in aging stands that are at or near the minimum thresholds of pine density and basal area to provide minimally suitable RCW habitat (e.g., at the MSS) elevates the risk of sustaining and recovery or RCW in the affected areas. These issues may result in further complications such as age-related "bottlenecks" associated with stand-level malaise and early senescence.

A 5-year study currently underway is focused on effectively converting off-site, declining, loblolly pine stands to native longleaf pine while preserving the maximum amount of RCW foraging habitat. This study will develop silvicultural protocols for site conversion and models to assess stand vulnerability to loblolly pine decline and to predict individual tree mortality, in order to prioritize stands to convert and in selecting leave-trees (USACE 2008).

A 3-year study was conducted on longleaf pine decline, which has also been observed on Ft. Benning. Objectives include gaining further understanding of the pathogenicity of the condition (potentially an exotic species of blue stain fungus species), developing a model to predict stand vulnerability to longleaf decline and determining the overall health and condition of longleaf stands on Ft. Benning (USACE 2008).

A recently funded research project will begin 2009 (USACE 2008). This project will focus on local and regional pine forest health issues, and forecast stand level implications of acute and chronic pine health problems relative to site conditions and RCW recovery standards. This study will also identify critical stand level forest health monitoring parameters.

Another study is integrating models of RCW population dynamics, forest growth, pine decline and forest management to provide Ft. Benning with a means to predict the effect of new Army training and related military projects on the RCW population (USACE 2008). This study will be completed sometime in 2009.

Ft. Benning is also investigating acquisition of various types of remote sensing imagery which could be valuable in identifying declining pine stands important for RCWs. Currently, researchers at the University of California at Davis are investigating "early-warning" detection techniques using Light Detection and Ranging (LIDAR) and other hyper-spectral imagery techniques. Early detection would allow Ft. Benning sufficient time to develop an appropriate stand level response and reduce the likelihood of pathogen transfer between adjacent trees and stands.

History of Fire on Ft. Benning

Ft. Benning has contracted Dr. Cecil Frost to conduct the necessary analyses and produce a report describing the pre-settlement/historic vegetative cover and fire history on the Installation. These data will assist Ft. Benning in determining which habitat on the Installation would have historically been subjected to periodic fire, and at what frequency and intensity. This will assist Ft. Benning with longleaf restoration on the Installation and could also be useful for management of any rare species, ranging from fire-dependent to fire-intolerant.

Additional Military Training Land

Most major Army installations, including Ft. Benning, are facing a training land deficit. Therefore, the Army has developed a strategy to examine its training land needs across the United States. This strategy not only identified shortfalls in available versus required training land, but listed four alternatives to address this shortfall: 1) buffering existing land (ACUB), 2) sustainable management on existing land, 3) use of other Federal/State land, and 4) purchasing additional training land. Ft. Benning is carefully considering all of these potential alternatives to address future training challenges.

If purchasing additional training land is determined as a feasible and reasonable course of action, the intent would be to purchase additional training land around Ft. Benning to address future mission training needs and enhance mission capability. Such a purchase may have the secondary effect of reducing the concentration of training on the existing acreage of Ft. Benning, thus potentially promoting RCW survivability and recovery. Feasibility factors for purchasing additional training land include: 1) cost effectiveness, 2) low human population density, 3) land that is accessible from Ft. Benning, 4) land that is compatible with environmental conditions and requirements, and 5) land that is available for sale by willing sellers.

ACUB Program

Through its partnership with TNC, Ft. Benning is already pursuing "off-post" conservation measures intended not only to buffer the Installation boundary from land uses incompatible with adjacent military training and land management, but also to protect and restore habitat for listed, imperiled, or at-risk species that impact Ft. Benning's mission (Figure 4). The ACUB Program at Ft. Benning was approved and funded by Army in 2006. Approximately half of the initial funding awarded to TNC in 2006-2007 was used to secure three parcels that buffer Ft. Benning's northeastern boundary, while providing important wetland and stream protection, gopher tortoise habitat protection/restoration and long-term RCW restoration potential. These parcels, totaling 873 acres, were purchased in fee. After restoration management has been initiated by TNC and Ft. Benning, the properties will be encumbered with permanent protective easements and will be sold to conservation buyers. In addition to this project, additional ACUB funding was used to acquire a 1,100-acre conservation easement on the northeastern corner of the Installation. This easement was a full donation from the landowner, and protects important Fall Line streams, wetlands and a significant population of relict trillium.

Additional projects under negotiation along or near the northern and eastern boundary include additional fee-purchase/conservation-buyer transactions, easement purchase transactions and a combination upland-easement/wetland mitigation bank project. In addition, the Army is making funding available to TNC for a 700-acre fee-purchase opportunity. Of the 3,300 TNC-owned ACUB acres projected through closing in 2009 and 2010, approximately 2,800 acres can eventually be restored to suitable RCW connectivity to the northern and eastern boundary of Ft. Benning.

The ongoing ACUB program has produced substantial mapping, land-use studies, habitat assessments, landowner outreach, and field reconnaissance which will be valuable in seeking "off-post" alternatives for offsetting some of the impacts of MCOE. To offset adverse impacts of the proposed action, the Army is proposing to accelerate the ACUB program substantially.

Adjacent RCW Habitat

The active ACUB projects on the northern and eastern boundaries of Ft. Benning provide opportunities for RCW habitat restoration. Portions of these parcels support loblolly pine plantation stands ranging up to 25 years old. With thinning and fire management these areas can support RCW foraging in a fairly short time-frame (5 to 30 years), and eventually nesting habitat (75 to 90 years). Conversion to longleaf pine can be part of this management over time, in much the same way that loblolly and shortleaf stands on Ft. Benning are gradually being converted via under-planting and opportunistic stand conversion. A necessary component of such a strategy would be a conservation easement and/or conservation banking instrument or long-term public-agency ownership (where willing sellers are available) that provides credible assurance of such restoration management. Funding mechanisms for such long-term management must also be determined.

Several fire-managed properties, with a single owner, located near Ft. Benning's western boundary provide another opportunity for additional RCW habitat amenable to occupation by Ft. Benning's population. Approximately 3,000 acres of these properties are frequently burned for wildlife management. Over 4,000 acres are already encumbered by a pre-ACUB conservation easement held by a local land trust. TNC and the Army have approached the landowner regarding protection of an additional 4,000 acres, 2,000 acres of which are upland pine.

Non-adjacent RCW Habitat

Large tracts of mature fire-managed pine habitat are located 5 to 50 miles west of the Installation (in Alabama) and approximately 10 miles south of Ft. Benning. One of these Alabama properties, approximately 30 miles west already has a conservation easement. This property has a small RCW population that was augmented by RCWs translocated from Ft. Benning in 2007. The property includes approximately 12,000 acres of mostly unoccupied but probably suitable RCW habitat. This landowner has shown interest in RCW management by becoming the first enrollee in Alabama's RCW Safe Harbor Program.

Several of the other Alabama properties and the Georgia property range in size from 2,000 to 5,000 acres. Some of these properties are known to have had small numbers of RCW groups in the past 10 to 20 years. One RCW from Ft. Benning was observed in eastern Alabama on Enon-Sehoy Plantation in 2008, which currently supports six active clusters. A private landowner has established a few thousand acres of longleaf pine plantation all less than 10 years old (7 miles east). This property is adjacent to an 800-acre TNC property, about half of which has 20-year old longleaf pine and which is now being managed for gopher tortoise habitat, groundcover restoration, and Fall Line wetlands. An ACUB-funded conservation easement for this 800-acre tract (Black Jack Crossing) has been drafted.

Management of Off-post RCW Habitat

Typically ACUB lands are owned in fee and managed by private landowners, non-profit organizations, or non-DOD public agencies subject to easements or deed restrictions that protect Army interests such as encroachment buffering or habitat protection. Urgent needs for habitat restoration and protection to enable endangered species recovery have created increased interest in additional mechanisms for long-term habitat management. Ft. Benning and TNC have explored the following strategies, some of which are being implemented:

- Access license and right-of-entry for Army land management staff and contractors to engage in land management practices on ACUB tracts, in collaboration with the landowner. The first example of these instruments has been finalized and is being implemented on TNC-owned ACUB tracts.

- Partnership with GA DNR to receive fee title to ACUB tracts as State Wildlife Management Areas to be managed in perpetuity by the State for public recreational activities and RCW habitat. Preliminary discussions with GA DNR are underway.

- Partnership with for-profit timber investment and/or conservation banking entities with business models that accommodate RCW habitat restoration and management. In this case, habitat management practices by the for-profit owner would be funded by the purchase of species credits by the Army. Preliminary discussions with for-profit entities are underway.

- Development of a conservation easement model that obligates the landowner to take affirmative action to restore habitat and manage RCW clusters, such that the easement grantee and/or the Army would have the right to step in and conduct such management should the landowner fail to do so. Such an easement is being negotiated as part of a TNC-Fort Polk ACUB transaction and is under consideration for adaptation to Ft. Benning's ACUB.

Proposed Habitat Conservation Outside of Ft. Benning to Offset the Impacts of the Proposed Action on the RCW

To provide assurances that it will accomplish the acquisition and long-term management of existing or potential habitat to benefit the survival and recovery of the RCW, the Army will, within one year of completion of formal consultation for the proposed action, develop an off-post habitat conservation plan (hereinafter "plan"). The Army will informally consult with the Service as it prepares a draft and final plan. The plan will include the following information, documents, procedures and guidelines:

1. A map identifying the geographic boundaries and a list of priority parcels targeted for conservation through acquisition of a perpetual conservation easement or fee title from willing landowners.

2. A corresponding explanation of the likelihood of the acquisition of an interest in each parcel, a projected time-frame for the acquisition, the existing habitat condition, and an assessment of the contribution the parcel will make to both the short and long-term recovery of the RCW.

3. A template habitat management plan describing a desired future condition for the parcel and management goals, objectives and practices necessary to achieve the desired future condition, and the projected cost estimate.

4. A template conservation easement assuring that uses of protected parcels are restricted to those compatible with RCW habitat conservation and requiring the easement holder to obtain perpetual access to the property to implement a parcel-specific habitat management plan.

5. A commitment of currently available funding for the acquisition of conservation easements and implementation of parcel-specific management plans with an initial target of not less than $9,000,000. The plan shall project the ratio of funds that will be dedicated to acquisition and long-term habitat management. This section should also include Ft. Benning's commitment to program and seek funding of its ACUB program for future fiscal years.

6. Identification of a financial instrument, such as an endowment or trust, necessary to provide for the long-term RCW habitat management on protected parcels.

7. Identification of the specific entity or entities responsible for the acquisition and holding of conservation easements and the long-term management of protected parcels with copies of agreements establishing the necessary legal relationships to carry out the foregoing responsibilities.

8. All land protected under the plan shall directly or indirectly promote the survival and recovery of the RCW. The plan shall include a procedure for informally consulting with the Service to seek concurrence prior to initiating acquisition of an RCW-related conservation easement on a specified parcel.

9. To the maximum extent practicable priority will be given to parcels that have the highest biological value for the conservation and recovery of Ft. Benning's primary core recovery population of RCW.

10. The plan shall identify parcels of land already protected through Ft. Benning's ACUB program that it seeks to include as an off-site conservation action. In order to be considered for inclusion, the Army must demonstrate that the pre-existing conservation parcel will directly or indirectly support RCW survival or recovery. A habitat management plan shall be developed and the Army must certify that the necessary instruments are in place and funding committed to assure long-term implementation of the parcel-specific plan.

11. The Army will provide an assessment of the effects of implementing the plan. Over the planning horizon, the Army will provide a projected time-line for near-term, mid-term, and long-term conservation easement acquisition and habitat management actions; predict the likely acreage to be protected and its condition; and provide a determination of the overall effect and contribution of off-post habitat protected under the plan to recovery of Ft. Benning's primary core population of RCW.

Ongoing and Future Monitoring Activities

Range Construction and Operation Impacts to RCWs and Habitat
As part of the minimization for the DMPRC and as directed, in part, as a RPM in the DMPRC BO (USFWS 2004), home range follows of RCW groups potentially affected by that project are being conducted to determine RCW reaction to construction and operation of a large caliber range. This range is currently under construction and is expected to be operational in 2010 (USACE 2008). By the time the proposed MCOE ranges are built, there should be applicable data on the reaction of RCWs to construction and training on the DMPRC. The types of training and artillery used on the DMPRC will differ from those on the proposed MCOE ranges; however, data from the DMPRC group follows will be applicable, in part, to the proposed multi-purpose machine gun ranges.

Habitat monitoring was also required in the DMPRC BO to document RCW foraging habitat degradation resulting from range operation (USFWS 2004). The *Impact of the Construction and Use of a Digital Multipurpose Range Complex on the Red-cockaded Woodpecker (Picoides borealis) Home Range and Habitat Use on Ft. Benning* (Ft. Benning 2004b) (DMPRC Habitat Monitoring Plan) was developed and submitted to the Service in August 2004. According to the BRAC BO (USFWS 2007), a Habitat Monitoring Plan to address BRAC/Transformation impacts will be submitted to the Service (due in July 2009). If impacts identified in the DMPRC Habitat Monitoring Plan and the forthcoming Transformation Habitat Monitoring Plan are inconsistent with those predicted for ranges in this MCOE BO document, Ft. Benning will seek input from the Service and reinitiate consultation, as necessary.

In addition to habitat monitoring around the DMPRC, FBCB and FBLMB will continue to implement the RCW foraging habitat monitoring recommendations in the 2003 Recovery Plan (USFWS 2003). Tracking the habitat available within RCW partitions Installation-wide, including changes in vegetative structure and composition, will be particularly important in monitoring the effects of MCOE on RCWs.

Population Level Modeling
Ft. Benning worked with Dr. Jeffery Walters of Virginia Polytechnic Institute to run population level modeling of the Ft. Benning RCW population. This model is helpful in predicting how RCW clusters may populate the Ft. Benning landscape in the future. The model requires a land coverage map as well as the locations of RCW clusters in order to predict how the birds may respond to habitat changes including reforestation, age and habitat removal. Several different scenarios were tested to provide additional information regarding various impacts associated with the Transformation and MCOE actions. Initial runs included the current Ft. Benning landscape to establish a baseline and determine if the current habitat configuration will support a recovered RCW population. Successive runs of the model determined how various projects may impact Ft. Benning's ability to reach its stated recovery goal. Ft. Benning provided model results to the Service on December 9 and 17, 2008, and in the March 23, 2009, addendum.

Evaluation of Transformation/MCOE Training Effects on RCWs
Ft. Benning contracted with Dr. Tim Hayden of the Engineer Research and Development Center (ERDC) to conduct a population viability analysis using Population Viability for Avian

Endangered Species computer model (PVAvES 1.0) to determine RCW population level effects of military disturbance. The model was used to answer the question: What is the probability of effects on RCW population viability if various proportions of RCW breeding habitat on Ft. Benning were subjected to high levels of potentially disturbing human activity? The population viability analysis provided a probabilistic evaluation of extinction risk over time and the recovery probability for the RCW population on the Installation. A preliminary baseline population viability analysis for the Installation's RCW population was provided to the Service on December 9 and 17, 2008, and in the March 23, 2009, addendum.

Training Area Access

With the increase in training activities and the number of new ranges proposed, access to training areas will become extremely challenging. The Access Plan for Transformation (Ft. Benning 2008b) will be updated as needed to allow access by FBCB and FBLMB personnel for activities such as RCW monitoring, cavity maintenance, timber management and prescribed burning in restricted areas such as those covered by Surface Danger Zones (SDZs). A Range Division Movement Control Center is planned to oversee the operations of the new ranges. This center should have the ability to track all activities in all training areas on the Installation. This level of organization has the potential to assist FBCB and FBLMB with scheduling the maximum amount of time in available "windows."

Co-Use and Subdivision of Current Training Compartments

Range users such as military units and FBLMB who wish to reserve areas for training, timber harvesting, prescribed burning or other activities typically must reserve entire training compartments to ensure that there is no conflict between them. Often, however, only a small portion of the compartment is actually used. For approximately 10 years, Ft. Benning has scheduled co-use of some training areas between military training exercises and other user groups. Over the past year, due to increased training demands on all training areas, Ft. Benning has worked to increase co-use of training compartments between compatible users. Co-use will continue to be a goal in non-live fire areas.

FBRD is also in the process of permanently sub-dividing some training compartments into smaller units. Dividing large compartments up allows users to reserve areas that are closer in size to the area they will actually use, leaving the remaining areas available to other groups. FBRD is coordinating with FBLMB to use some of the boundaries that FBLMB has created to subdivide larger compartments into burn units. Increasing co-use and redrawing compartment boundaries will help to minimize scheduling conflicts, ensuring that protected species and their habitat continue to be sufficiently managed and monitored post-BRAC and post-MCOE.

Demographic Monitoring at Affected RCW Clusters

In the *Red-cockaded Woodpecker Demographic Monitoring Plan* (Transformation Monitoring Plan) (Ft. Benning 2008a), Ft. Benning agreed to monitor all clusters directly impacted by any project and all clusters with cavity trees within 200 ft. of road projects and/or within 0.5 mile of any proposed BRAC project that is removing RCW habitat. These distances are in accordance with guidelines described in the 1996 Army-wide Guidelines and the 2003 Recovery Plan (USDOA 1996, USFWS 2003). This includes all adversely affected clusters. Monitoring includes banding of all adult and nestling RCWs in the cluster, and will be conducted for five years after project completion and/or training initiation. Clusters requiring translocation as a result of cavity tree removal will have all birds banded prior to translocation (Ft. Benning 2008a). The Transformation Monitoring Plan will be updated or a similar plan will be developed to incorporate additional monitoring requirements from the proposed MCOE actions.

Demographic monitoring will allow Ft. Benning to detect and react to unexpected impacts to RCWs from project construction and operation. Each monitored cluster will be visited by a biologist several times a year. This field time will allow the biologist to track the status and health of RCW groups and cavity trees/clusters. If this monitoring identifies unexpected and detrimental impacts, Ft. Benning will consult immediately with the Service to determine the appropriate course of action.

Habitat Monitoring at Affected RCW Clusters

Ft. Benning plans to establish vegetation monitoring plots within a 0.5-mile radius of the Southern Maneuver Area and downrange of the MPMG and the Oscar small arms range complex and other ranges as necessary using methodology established with the DMPRC vegetation monitoring plots. This habitat monitoring will be conducted for at least five years after project completion. These data will document the effect of heavy maneuver training, down-range munitions and small arms range impacts on vegetation. Data collected from habitat monitoring will validate assumptions regarding potential project effects (such as the placement of habitat protection berms), and aid in future range and maneuver area impact assessments. Details of the habitat monitoring will be provided in the Habitat Impact Assessment Plan that will be completed by July 2009.

Habitat monitoring will allow Ft. Benning to detect and react to unexpected impacts to RCW habitat from project construction and operation. If this monitoring and analysis identifies unexpected and detrimental impacts, Ft. Benning will consult immediately with the Service to determine the appropriate course of action.

Compliance Monitoring

Higher mission loads and more personnel who will be unfamiliar with training on a landscape with endangered species will necessitate an increase in monitoring efforts to make sure that all personnel using/training on Ft. Benning are complying with the training restrictions detailed in the Army RCW Guidelines (USDOA 1996, 2007). To ensure that new troops are training within the guidance, inspections will need to be increased, at least initially. Inspections will involve visiting clusters in training compartments scheduled in Range Facility Management Support System (RFMSS) for use that day. Inspections will document troop presence and adherence to the guidelines and if violations are noted, troops will be asked to correct their actions and repair any damage. Reports will be submitted to FBCB and reports for violations will also be submitted to FBRD. Violations noted when no troop presence was detected will also be submitted to FBRD for corrective measures. Ft. Benning has requested funding for one person in FY09 and three persons in FY10 who would assist with increased compliance monitoring as well as other additional monitoring requirements

STATUS OF THE SPECIES

Federally Protected Species Considered

This BO evaluates the potential impacts of the proposed MCOE actions on species listed as threatened or endangered, or proposed for such listing, pursuant to section 7 of the Act, as amended that occur on Ft. Benning or have been recorded in the surrounding region. The subject species are relict trillium, Michaux's sumac (*Rhus michauxii*), purple bankclimber mussel (*Elliptoideus sloatianus*), shinyrayed pocketbook (*Lampsilis subangulata*), gulf moccasinshell (*Medionidus penicillatus*), oval pigtoe (*Pleurobema pyriforme*), wood stork (*Mycteria americana*) and the RCW. Also, as of November 15, 2007, there is designated critical habitat for the shiny-rayed pocketbook on Ft. Benning along Uchee Creek in Russell County, Alabama (Federal Register 72: 64285-64340).

The American alligator is protected due to similarity of appearance to a threatened taxon throughout its entire range under provisions of the Act, as amended (USFWS 1987) due to its similarity to other endangered species of crocodiles and caimans. The Service regulates the legal trade of skins, or products made from them, in the commercial trade. Because the alligator is regulated in order to prevent illegal trade, and there is no import/export aspect to the proposed action, potential project impacts to the alligator were not assessed and are not expected (Federal Register 52: 21059).

Bald eagles (*Haliaeetus leucocephalus*) are no longer protected under the Act; however, they are protected under the Bald and Golden Eagle Protection Act (Eagle Act) (16 U.S.C. 668-668d) and the Migratory Bird Treaty Act (16 U.S.C. 703-712). Impacts to eagles are not expected for the proposed action.

There are no effects from the action expected for Michaux's sumac, purple bankclimber, Gulf mocassinshell, and oval pigtoe because they do not occur within the action area. The shinyrayed pocketbook is not known to occur within the action area though it is known to occur in Uchee Creek west of the Installation (Brim Box and Williams 2000). There are no components of the proposed action that will affect Uchee Creek. Mussel surveys were conducted by the Service in May and June of 2006 at 27 locations on Ft. Benning. Only two native mussel species were found; none of which are listed entities (USFWS 2006d). The wood stork is a transient species that occasionally forages in the action area within swamps and wetlands, but is not expected to be exposed to effects from the action because the action is in pine uplands.

In their 2008 biological assessment, the Army made a determination that only the RCW and relict trillium would be adversely affected by the proposed action. We concur with that determination. Thus, other listed species or their critical habitat in the action area are considered no further in this biological opinion.

Species evaluated for effects of MCOE impact, Fort Benning, Georgia.

SPECIES	PRESENT IN ACTION AREA	PRESENT IN ACTION AREA BUT NO EFFECT	CRITICAL HABITAT
Wood stork	Yes	Yes	N/A
Michaux's sumac	No	N/A	N/A
Purple bankclimber	No	N/A	N/A
Gulf moccasinshell	No	N/A	N/A
Oval pigtoe	No	N/A	N/A
Shinyrayed pocketbook	No	N/A	yes

Red-cockaded Woodpecker

Species/critical habitat description

The U. S. Department of the Interior (USDI) identified the RCW as a rare and endangered species in 1968 (USDI, 1968). In 1970, the RCW was officially listed as endangered (Federal Register 35:16047). With passage of the Act in 1973, the RCW received the protection afforded listed (endangered) species under the Act. No critical habitat has been designated.

The RCW is a small woodpecker about 8 inches in length, with a wingspan of about 14 inches, weighing about 1.7 ounces (47 grams). Its coloration is black and white, with a ladder back, and is distinguished from other woodpeckers by its black capped head and nape, surrounding large, white cheek patches. Adult males possess a tiny red streak or tuft of feathers, the cockade, in the black cap near each ear and white cheek patch. The small cockade usually is covered by the black crown, except when protruded during excitement, and is not readily visible except upon close examination or capture. Adult males and females are not readily distinguishable in the field. Juvenile males have a red crown patch until the first molt, which can be distinguished from the black crown of juvenile females (USFWS 2003).

Life History

The RCW is a territorial, non-migratory, cooperative breeding species (Lennartz et al. 1987; Walters et al. 1988). It is unique in that it is the only North American woodpecker that exclusively excavates its cavities for roosting and nesting in living pines. Usually, the trees chosen for cavity excavation are infected with a heartwood decaying fungus (*Phellinus pini*) (Jackson 1977; Conner and Locke 1982). The heartwood associated with this fungus and typically required for cavity excavation is not generally present in longleaf pine and loblolly pine until 90 to 100 and 75 to 90 years of age, respectively (Clark 1992a; Clark 1992b). Large trees also are required because the cavity is constructed and placed entirely within heartwood where pine resin will not flow. Each group member has its own cavity, although there may be multiple cavities in a cavity tree. RCWs chip bark and maintain resin wells on the bole around the cavity where the fresh flow of sticky resin is a deterrent against predatory snakes (Rudolph et al. 1990) and indicates an active cavity tree. The aggregate of cavity trees, surrounded by a 200-foot, forested buffer, is called a cluster (Walters 1990). Cavities within a cluster may be complete or under construction (starts) and either active, inactive or abandoned. Clusters with one or more active cavity tree are considered as active RCW clusters.

Red-cockaded woodpeckers live in social units called groups. This cooperative unit usually consists of a monogamous breeding pair, offspring of the current year, and 0 – 4 adult helpers (Walters 1990). Helpers typically are male offspring from previous breeding seasons that assist the breeding pair by incubating eggs, feeding the young, excavating cavities, and defending the territory (Ligon 1970, Lennartz and Harlow 1979, Lennartz et al. 1987, Walters et al. 1988). Some large populations have instances, although very infrequent, of female helpers (Walters 1990; Delotelle and Epting 1992; Bowman et al. 1998). Some clusters are only occupied by a single adult male, which are classified as single bird groups.

The RCW is territorial and each group defends its home range from adjacent groups (Hooper et al. 1982; Lignon 1970). The defended territory includes habitat used for cavity trees and foraging. RCWs feed mostly on variety of arthropods, particularly ants and wood roaches, by foraging predominately on and under the bark of larger and older living pines (Hooper 1996; Hanula and Franzreb 1998). Males tend to forage in crowns and branches, while females commonly forage on the trunk. Dead and dying pines are important temporary sources of prey, and hardwoods are used occasionally. Group members forage together each day in parts of their territory.

RCWs have large home ranges relative to their body size. RCWs tend to forage within 0.5 miles of their cluster. RCW groups forage within a home range that is highly variable, from as little as 86 acres to as much as 556 acres (Conner et al. 2001; USFWS 2003). Home range size is variable within and between populations, but tends to reflect foraging habitat quantity and quality, boundaries of adjacent RCW territories, and possibly cavity tree resource availability (Conner et al. 2001; USFWS 2003).

Because of the foraging behavior of RCWs, a 0.5-mile radius is used to conduct survey areas, prior to clearing or removing any potential RCW habitat, to identify any unknown RCW clusters that may be affected. The 0.5-mile survey area provides a high probability that any unknown clusters will be identified that potentially use habitat within the area to be affected. This is based on RCW foraging ecology and behavior, the limitations of natural cavities to population growth at Fort Benning, the ecology of RCW population growth via the formation of new clusters/groups, and relationship of habitat used for foraging within 0.5 miles of a cluster center.

A 0.5-mile radius circle around a cluster center encompassed an average of 91% of the actual home ranges of RCW groups in a North Carolina study (Convery and Walters 2003). Thus, unknown Ft. Benning clusters identified by surveys within 0.5 miles of the edge of clearing or construction likely will have the vast majority of their foraging habitat somewhere within this 0.5 mile area.

About 90 percent of potential breeding groups (PBG) nest each year. A PBG is an adult male and female with or without helpers occupying the same cluster. The nesting season occurs from April to July. Females usually lay 3 or 4 eggs in the cavity of the adult male. The short incubation period lasts approximately 10 days, and eggs hatch asynchronously. Nestlings fledge after 24 to 29 days, although all nestlings rarely survive to fledglings. Partial brood loss of nestlings is common in RCWs, although number of hatchlings successfully fledged tends to increase with group size. Also, older and more experienced breeders have greater reproductive success (number of fledglings), which is maximized at about 7 years of age, after which it declines sharply at 9 or greater years of age (Reed and Walters 1996). About 20 percent of nests will fail completely, without producing a single fledgling. Groups with helpers experience whole brood loss less frequently than breeding groups without helpers. Renesting rates are geographically and annually variable. In good years, up to 30 percent of breeding groups will renest. Productivity of the second nesting is lower.

Subadult/juvenile females from the current year breeding season normally disperse prior to the next breeding season, or are driven from the group's territory by the group (see Walters et al.

1988, for additional sociobiological/cooperative breeding information). Juvenile females remain at their natal territory to assume the breeding vacancy of the female only when the breeding male dies and the breeding female disperses or dies. Breeding females will disperse, creating a breeding vacancy, when her male offspring inherit the male breeding position (incest avoidance). Dispersing juvenile females move to nearby RCW territories in search of a breeding vacancy. These females either become breeders in a territory, or floaters among more than one territory where they are not associated with a single group.

Juvenile males remain in their natal territory or disperse. Those that remain become helpers or, if the breeding male dies before the next breeding season, breeders. Dispersing juvenile males search for positions as breeders in nearby territories where they either become breeders, helpers, or floaters.

Most adult male helpers remain on their natal territory as helpers, where about 15 percent will inherit the territory as a breeding male in any given year. Some adult helpers disperse to other territories becoming breeders, solitary males, helpers, or floaters. However, breeding males are highly territorial and most will remain even without a breeding female. In contrast, about 10 percent of breeding females will break the pair-bond between breeding seasons and disperse to another territory as a breeder with a different male (Walters 1988; Daniels and Walters 2000).

<u>Population Dynamics</u>

RCW population size during a given year is the number of surviving adults, plus the number of surviving offspring produced, the number of immigrants to the population, and minus the individuals that dispersed from the population. These are the demographic rates of birth, death, immigration, and emigration that affect population dynamics. However, RCW population dynamics are significantly affected by the cooperative breeding system and behavior of territorial RCW groups with helpers. The spatial distribution and aggregation of groups affects the likelihood that breeders in a group will be replaced upon their death or dispersal by other RCWs. All of these factors regulate population size, stability, and viability as mediated by the effects of habitat, genetics, demographic and environmental stochasticity, and environmental catastrophes.

<u>Population Size</u>

RCW population size is commonly measured as the number of groups instead of the number of individuals. The number of PBGs is an important metric for population dynamics and persistence. A single-bird (male) group is a solitary territorial male at a cluster without a female. Single-male groups, while not breeders also are important because a large proportion of single-bird groups are indicative of a declining population. Although the total number of birds in a population can be measured or estimated, this number includes non-breeding adults as helpers and floaters. Population measures of all individuals does not account for group and territory dynamics or the buffering effect of helpers as a replacement pool for breeders.

A PBG is determined by confirmation of nesting or careful observation of a coexisting adult pair in the cluster and territory in the absence of nesting or during the non-nesting season. Single-male groups are determined using the same observational methods of following birds during foraging in the early morning after they have exited their cavities.

In the absence of data for the number groups and group composition, the number of active clusters is an index estimate of population size (number of groups). An active cluster is a group cluster where fresh resin from RCW activity at a suitable cavity occurs on one or more cavity trees. An active cluster may be occupied by PBG or a single-male group. In large populations, the number of PBGs and single-male groups frequently are estimated by an active cluster census from which there is a random sample determining the number and composition of groups. The proportion of PBGs and single-male groups in the sample is extrapolated to the total number of active clusters to estimate the total number of PBGs and single-male groups.

The term "population" is applied for RCWs in various contexts, just as it is for other species. A RCW population can be the number of clusters or groups occupying a particular geographic area or on a specific property managed by a particular agency or entity. However, RCW population size is most important as an attribute of a biologically functional population of spatially distinct demographic and/or genetic groups (e.g., Wells and Richmond 1995). Demographically, a RCW population is strongly affected by the dispersal distances of males and females from their natal group or group territories that search for and compete for breeding vacancies at other groups. Dispersing juvenile and helper males rarely move and assume breeding vacancies at clusters located more than 2 miles from their natal or group site at North Carolina study sites (Daniels 1997; Walters 1988). Juvenile females from the same study areas (North Carolina sandhills and Camp Lejeune) are capable of longer forays, becoming breeders at clusters up to 3.7 miles away (Walters et al. 2008). In western Florida (Eglin Air Force Base), from a study with a smaller number of observations, adults disperse an average distance of 1.1 mile, juvenile females 2.0 miles, and juvenile males 5.0 miles (Hardesty et al. 1997b). Thus, the spatial structure and distribution of groups is a crucial factor defining a demographically functional RCW population and its size (see Population Stability for further information).

RCW populations under natural conditions increase in size (number of group territories) by two primary processes; pioneering and budding. Pioneering is the creation of new cavities and colonization of a new, previously unoccupied territory. Pioneering rarely occurs under current conditions, with rates (new groups) of only 0.06 to 1.5 percent per year (USFWS 2003). Budding is the creation of a new group by subdividing an existing group territory and its cavity trees, usually by a group helper or an immigrant male (Conner et al. 2001). Annual budding rates also are low, from 0.6 to 2.1 percent.

Population Variability

The attributes for which RCW populations are variable reflect environmental variation at different scales. The effects of variability in population size, spatial distribution of groups, and demographics on population stability and persistence are described in the following sections on population stability, range-wide trends, and threats. This section addresses the nature of variation and RCW response. RCW populations experience environmental variation within and between physiographic regions, ecosystems, forest communities, forest stands, and individual trees. However, the fundamental ecology of RCWs remains the same where populations occupy fire-maintained, open pine forests, with pine of sufficient age and size for cavities and foraging.

Most RCW populations reside in the longleaf pine ecosystem where longleaf pine historically dominated the forest community, providing cavity resources and foraging substrate. Populations in other vegetation types occur in the western, northern interior and southernmost regions flanking the longleaf pine ecosystem. Populations in the West Gulf Coastal Plain occupy loblolly pine forests in parts of southern Arkansas, east Texas, and Louisiana on flatwood terraces and more dissected upper terraces where loblolly pine was dominant or with shortleaf pine as a natural community type (e.g., Moore and Foti 2005; Moore and Foti 2008). Shortleaf pine-dominated communities currently with RCWs are in portions of the coastal plain in east Texas, the Ouachita Mountains of Arkansas and eastern Oklahoma, the Piedmont and Cumberland Plateau of Alabama, and the Georgia Piedmont. In south Florida, RCWs persist in hydric pine flatwoods dominated by South Florida slash pine (*Pinus elliottii* var. *densa*). In northeastern North Carolina and southeastern Virginia, small populations remain associated with pond pine (*Pinus serotina*) communities and pocosins.

Variation among forest ecosystems is not known to significantly alter RCW population demographics or dynamics under natural conditions. However, variation in habitat quality and quantity is associated to some extent with some forest community types. For example, longleaf community types and forest structure vary in response to soil moisture and drainage, from xeric excessively well-drained types on deep sandy soil, to wet types in flatwoods and savannas with seasonally perched water tables (Peet and Allard 1993; Christensen 2000). The density and size of longleaf pine is reduced at these most xeric and wet communities or sites, which reflects slower pine growth rates than at more productive mesic sites and community types. Similarly, the size and density of South Florida slash pine in hydric flatwoods also is reduced relative to more productive sites. The average RCW home range size tends to be greater at such xeric and wet communities or sites in Florida than more productive pine sites in Georgia and South Carolina (Nesbitt et al. 1983; DeLotelle et al. 1987, 1995; Epting et al. 1995; Hardesty et al. 1997).

However, home range size of groups also varies within populations and among years and seasons. Within populations, the largest home ranges are about the twice the size of the smallest (Conner et al. 2001). Home range size has been related to the area of suitable habitat within 1.24 miles of the cluster, pine basal area, pine density, pine density greater than 9.84 inches dbh, RCW group density, hardwood midstory, and other factors (Hooper et al. 1982; DeLotelle et al. 1987; Bowman et al. 1997; Hardesty et al. 1997; Walters et al. 2000, 2002). Variation in home range size reflects a response to habitat quality, where more is generally required in low quality habitat, and less is needed in high quality habitat.

RCWs selectively forage in their home ranges on larger and older pines more frequently than their availability relative to younger and smaller trees in small habitat patches, patches within stands, and stands within the landscape (Zwicker and Walters 1999; Walters et al. 2002). The degree of preference and the composition of large, intermediate, and small trees vary within and among home ranges and the sites where these factors have been studied. Overall, RCWs preferentially use pine 12 – 20 inches dbh, prefer trees greater than 20 inches dbh, use trees less than 20 inches dbh depending on the availability of larger trees, and avoid trees less than 12 inches dbh when larger trees area available (Walters's et al. 2000).

RCW group fitness or reproductive success is directly and indirectly affected by the age and size of available pine, as well as the development of the herbaceous plant ground cover. RCW group size, productivity (fledglings produced), or both is positively related to an increase in the density of old and large pine and the herbaceous ground cover. It is negatively related to an increasing density of small young pine, intermediate-size pine, and the density and height of the hardwood midstory (Conner and Rudolph 1991; Rudolph and Conner 1994; Hardesty et al. 1997; Engstrom and Sanders 1997; James et al. 1997, 2001; Walters et al. 2002). Group size affects productivity because the number of fledglings increases with group size, generally with an average of two fledglings in groups of 4 – 5 adults and helpers, and 1 fledgling on average with groups of just two breeding RCWs (Conner et al. 2001).

Habitat quality is not a function of any single attribute. For example, RCW fitness is not solely related to the number, basal area, or density of pine greater than 10 inches dbh (Hooper and Lennartz 1995; Beyer 1996; Wigley et al. 1999; James et al. 2001; Walters et al. 2002). Collectively, the attributes of RCW habitat use affecting RCW fitness are the characteristics of habitat structure, which include the density and size-class distribution of pine. High quality RCW foraging habitat consists of an open fire-maintained pine forest, with no or a sparse midstory of hardwood or pine, low densities of small pine (less than 10 inches dbh), moderate densities of medium-sized (10 – 14 inches dbh) and large (greater than14 inches dbh) pine, at least low densities of old growth pine, and a well-developed herbaceous plant ground cover (James et al. 2001; Walters et al. 2002). Understanding the contribution of old growth to habitat quality has been limited by the rarity of this habitat, although RCWs from the old-growth Wade Tract in southern Georgia have the smallest average home ranges and the greatest average group size and productivity known. Thus, old growth is expected to be an important element of habitat quality, both for foraging and cavity resources.

Variation in habitat quality occurs within and between populations, much of which is attributable to current and past forest management and land use practices. On a broader geographic scale, population-level differences in RCW mortality and fecundity also exist, apparently independent of habitat quality (Conner et al. 2001). RCWs in southern and coastal RCW populations tend to have lower productivity and greater survival rates than more northern and inland populations (Lennartz and Heckel 1987; DeLotelle and Epting 1992). These differences may be due to lower winter temperatures and survival with greater reproductive effort in northern populations, and life history evolution in more favorable southern climates where greater survival and lower annual reproduction are responses to increased competition (Conner et al. 2001).

Genetically, most variation is partitioned (greater than 86%) among individuals within populations, rather than among populations (14%), according to allozyme (Stangel et al. 1992; Stangel and Dixon 1995) and random amplified polymorphic data (Haig et al. 1994, 1996). Population heterozygosity remains comparable to other bird species. Unique alleles are not known to distinguish populations. The genetic structure of populations is significantly, although weakly, spatially heterogeneous (overall $F_{ST} = 0.14$, p less than 0.0001, Stangel et al. 1992; $F_{ST} = 0.19$, p less than 0.0001, Haig et al. 1994), but somewhat more structured than in most non-endangered birds (Haig et al. 1994). Genetic distance (dissimilarity) tends to increase as the geographic distance between populations (Stangel 1992; Haig et al. 1994, 1996) increases. Mean heterozygosity among populations is relatively high and comparable to other species, although allelic diversity in some small populations is reduced (Stangel et al. 1992). These genetic characteristics are generally expected by a historically widely distributed species that only relatively recently has become reduced in fragmented populations (USFWS 2003). However, inbreeding depression recently has been detected within a relatively large population, adversely reducing rates of hatching and fledgling survival (Daniels and Walters 2000).

Population Stability

Viable RCW populations are robust and highly persistent, in contrast to a population vulnerable to future declines and extirpation. RCW population viability depends on a sufficient number of stable groups to avoid adverse effects of inbreeding, and impacts from stochastic genetic, demographic, environmental, and catastrophic events (Shaffer 1981). Inbreeding depression is a consequence of breeding among closely related adults producing offspring with deleterious homozygous recessive alleles that reduce fitness. Genetic drift is the loss of alleles and genetic diversity by the fluctuation of gene frequencies from random mating events. Demographic stochasticity is the random or chance variation in survival and reproductive rates. Environmental stochasticity is variation in vital demographic rates and processes in response to annual, seasonal, or other changing environmental events such as rainfall, temperature, predation, food resources, and other factors. Catastrophes are naturally occurring but infrequent events such as hurricanes, tornadoes, and large-scale pine beetle outbreaks that affect mortality, reproduction, or other features of RCW population dynamics at a greater magnitude over a shorter period. All of these factors operate simultaneously to affect RCW population dynamics and viability. Small populations are particularly more sensitive to exacerbating effects of these stochastic factors (Shaffer 1981; Soule 1987, Clark and Seebeck 1990), which can drive local extirpation or extinction (Gilpin and Soule 1986).

Population viability analysis (PVA) is a quantitative assessment of the future status of populations based on the factors affecting population growth, decline, persistence, and extirpation (Morris and Doak 2002). Common PVA approaches modeling population growth and decline as a demographic and environmental function of rates of reproductive and survival of offspring and breeding adults do not adequately represent the RCW cooperative breeding system and group dynamics. Mortality rates vary among breeding males and females, juveniles, male helpers, male and female floaters. Furthermore, group size and breeder age affects productivity, and surviving helper males, floater males, juvenile males, and juvenile females have different life stage transition probabilities of becoming breeders.

Heppel et al. (1994) used a stage-based deterministic model, without stochastic effects, of males (without females) to evaluate some of these dynamics. However, they recognized that a spatially explicit, individual-based population model (SEPM) was needed to accurately simulate the dynamics of helper males filling breeding vacancies in or near their group territory, as well as the effects of juvenile and adult male and female dispersal to other territories. SEPMs simulate the movement and fate of each individual in a population depending on its status. SEPMs are currently the best available and most accurate models simulating RCW population dynamics and viability (e.g., Letcher et al. 1998; Daniels et al. 2000; Walters et al. 2002b).

RCW SEPMs have revealed significant effects of spatial structure and distribution of groups on viability. This reflects the relatively short dispersal distances of male juveniles and helpers (2 miles); and females (3.7 miles) to inherit breeding vacancies in nearby territories (Walters 1988, Daniels 1997, Walters et al. 2008). Thus, groups located at greater distances and at lower densities are much less likely to sustain breeding pairs, becoming demographically isolated and more vulnerable to local extirpation.

The performance of the RCW SEPM described in the following sections has been compared by model predictions relative to actual data sets from two populations (Schiegg et al. 2005). Predictions for most parameters were highly accurate, although the model is sensitive to female and male search range and dispersal behavior (e.g. Letcher et al. 1998), where it tends to overestimate dispersal success. The model assumes no habitat limitations or effects on any of the parameters.

Demographic Stochasticity

With the added effects of demographic stochasticity, Letcher et al. (1998) found that small populations with 49 highly aggregated groups are stable over 100 years, and smaller populations of 25 highly aggregated groups were highly persistent for about 60 years. Highly aggregated groups share common territorial boundaries. Even smaller, highly aggregated populations of 20 and 10 groups have good persistence for 20 years, although population growth rates are less than 1.0 and slowly declining (Crowder et al. 1998). Highly aggregated populations of 49 groups are more stable than minimally aggregated populations of 169 or 250 groups. Populations with less than 100 groups that are not highly aggregated decline and are not viable. Regardless of the aggregation or clumping of the modeled populations in their study (Letcher et al. 1998), populations of 500 groups were viable. Also, moderately aggregated groups of 250 were stable.

The density of populations with 49, 100, and 169 groups modeled on the simulated landscape (189,776 acres) at different aggregations by Letcher et al. (1998) represented the density of known populations, respectively, from Croatan National Forest (1 group per 3,873 acres), Marine Corp Camp Lejeune (1 group per 1,898 acres), and the North Carolina Sandhills (1 group per 1,123 acres) landscapes. Species with populations of 50 or more individuals generally are not vulnerable to declining and extirpation by demographic stochasticity (Meffe and Carroll 1994). However, spatial structure strongly affects viability of RCW populations with fewer than 50 groups under stochastic demographic fluctuations. The strong persistence of highly aggregated RCW populations with less than 50 groups reflects the demographic effect of a nonbreeding class (helpers) of individuals. Variation in breeder mortality is dampened by helpers that replace breeders. Fluctuating periods of greater breeder mortality tends to reduce the size of the helper class instead of reducing the number of breeding groups (Walters et al. 2002).

Environmental Stochasticity

RCW environmental stochasticity is represented by the variation in demographic rates and group make-up among years. The RCW SEPM with demographic and environmental stochasticity (Walters et al. 2002) used the same simulated landscape (189,776 acres) as Letcher et al. (1998), although only populations of 25, 49, 100, 250, and 500 groups were modeled at minimally (random) aggregated and moderately aggregated densities. Moderately aggregated groups reflected the level of aggregation Walters et al. (2002) considered as likely representative of most current RCW populations. Two higher levels of density were investigated, while controlling for the effects population size.

Overall, Walters et al. (2002) concluded that RCW population persistence and viability in response to demographic and environmental stochasticity was similar to that of comparable populations affected only by demographic stochasticity. The added effects of environmental stochasticity were relatively small compared to viability analysis of other species. Once again, the nonbreeding class of helpers in the RCW cooperative breeding system had a buffering effect on breeder mortality and loss of breeding groups.

RCW populations of 250 and 500 groups were stable and viable at moderately aggregated and random patterns of group clumping. Populations of 100 groups are viable only at the highest levels of aggregation. Populations of 25 and 49 groups persisted longer at the highest aggregation and densities, but none were long-term viable and the probability of extinction (no surviving territories after 100 years) ranged from 0.15 to 1.0.

Inbreeding

Daniels et al. (2000) used a RCW SEPM to assess potential inbreeding effects with demographic and environmental stochasticity to viability in small populations of 25, 49 and 100 groups with a moderate level of group aggregation. In earlier studies, Daniels and Walters (2000) documented actual effects of inbreeding depression in RCWs to reduced egg hatching success and fledgling survival. However, the SEPM to assess potential inbreeding effects did not directly incorporate reductions in RCW fitness to demographic variables. Instead, Daniels et al. (2000) computed coefficients of kinship for each breeding pair (inbreeding coefficient of offspring) and mean kinship of RCW pairs to identify pairs that were unrelated, moderately related, and closely related. Kinship by pedigree analysis was compared to inbreeding estimates from population genetics models.

Daniels et al. (2000) found that inbreeding depression is a serious viability threat to small, isolated, and declining RCW populations. RCW populations of 25 and 49 groups declined, as in other RCW SEPMs. The stable population of 100 groups was only marginally persistent over their 50-year simulation period, and may not have been stable if simulated for a 100-year period. The mean percentage of closely related breeding pairs increased for all populations. Closely related breeding pairs were most prevalent in populations of 25 and 49 groups, which were at risk of extremely high inbreeding. However, two or more immigrants to these populations per year could stabilize a declining trend and reduce significantly the number of closely related breeding pairs.

Catastrophes

Hurricanes, tornadoes, and southern pine beetles are the primary catastrophic events affecting RCW population stability. These events damage or destroy habitat, reducing the number of breeding groups by the loss of cavity trees and foraging habitat.

Hurricanes are the greatest catastrophic threat, as indicated by their frequency, widespread distribution, intensity, and effects (Hooper and McAdie 1995). Hurricane Hugo, a category IV storm, destroyed about 87 percent of RCW cavity trees in the Francis Marion National Forest, reducing the estimated pre-storm population of 477 active clusters to 277 clusters with at least one remaining cavity tree (Hooper et al. 1997; Watson et al. 1997). The Francis Marion population, at that time, was one of the largest. Populations half the size could have been extirpated. Coastal populations, particularly small populations, are highly vulnerable while the most inland populations are at least risk. RCW populations in the Croatan National Forest (SC), Francis Marion National Forest (SC), Apalachicola National Forest (FL), DeSoto National Forest (MS), Eglin Air Force Base (FL), and Conecuh National Forest (AL) and nearby regions are the most vulnerable based on hurricane return periods and intensity (Hooper and McAdie 1995).

Southern pine beetle epidemics adversely affect loblolly pine much more than longleaf, which have greater resin production and resistance to attack. The loss of off-site planted loblolly pine, which was planted in much of the historic longleaf pine range, as well as loblolly in its natural habitat, can be locally significant. More than 50 RCW groups lost all loblolly cavity trees in the Sam Houston National Forest in the 1980s, where more than 300 cavity trees were killed by beetles between 1982 and 1984 (Conner et al. 2001). Loss of cavity trees in small populations with limited cavity trees can be locally severe, leading to a reduction in breeding groups and potentially threatening local extirpation in small populations.

Status and Distribution

Reasons for listing

The RCW was one of the first listed species, added as endangered in 1970 in accord with the 1969 Endangered Species Conservation Act. The factors or reasons for listing were not included in that proposed list (35 FR 16047-16048) of over 90 fish and wildlife species. In 1971, the first RCW symposium described information on status, threats, and reasons for decline (Thompson 1971). These factors included loss of forest habitat by commercial forest management practices, with cutting cavity trees, loss of mature pine by short rotation forest silviculture, a reduction in historic range and abundance, and agriculture and urbanization.

The precipitous decline of RCWs was caused by an almost complete loss of habitat. Prior to European settlement, the number of RCW groups inhabiting longleaf pine forests and all southern pine forests has been estimated at 920,000 (USACE 2008) and 1.5 million (USFS, D. Conner et al., 2001), respectively. Fire-maintained old growth pine savannahs and woodlands that once dominated the Southeast (92 million acres pre-European settlement; Frost 1993), on which the RCWs depend, no longer exist except in a few small patches (less than 3.0 million acres today; Frost 1993). Longleaf pine ecosystems, of primary importance to RCWs, are now among the most endangered systems on earth (Simberloff 1993; Ware et al. 1993).

Loss of the original pine ecosystems was primarily due to intense logging for lumber and agriculture. Logging was especially intense at the turn of the century (Frost 1993).
Two additional factors resulting in the loss of the original pine systems in the 1800's and earlier were exploitation for pine resins and grazing of free-ranging hogs (Wahlenburg 1946, Frost

1993). Later in the 1900's, fire suppression and detrimental silvicultural practices had major impacts on primary ecosystem remnants, second growth forests, and consequently on the status of RCWs (Frost 1993, Ware et al. 1993, Ligon et al. 1986, 1991, Landers et al. 1995). Additionally, longleaf pine suffered a widespread failure to reproduce following initial cutting, at first because of hogs and later because of fire suppression (Wahlenburg 1946, Ware et al. 1993).

Threats

Primary threats to species viability for RCWs all have the same basic cause: lack of suitable habitat in a fire-maintained ecosystem. On public and private lands, the quantity and quality of RCW habitat are impacted by past and current fire suppression and detrimental silvicultural practices (Ligon et al. 1986, 1991, Baker 1995, Cely and Ferral 1995, Masters et al. 1995, Conner et al. 2001). Serious threats stemming from this lack of suitable habitat include: (1) insufficient numbers of cavities and continuing net loss of cavity trees (Costa and Escano 1989, James 1995, Hardesty et al. 1995), (2) habitat fragmentation and its effects on genetic variation, dispersal and demography (Conner and Rudolph 1991), (3) lack of good quality foraging habitat (Walters et al. 2000, James et al. 2001), and (4) fundamental risks of extinction inherent to critically small populations from random demographic, environmental, genetic, and catastrophic events (Shaffer 1981, 1987).

RCWs and population size are significantly limited by the availability of cavity trees and suitable, stable clusters. The natural growing season fire regime has been lost due to fire suppression and landscape alterations that have altered the availability of lightning-flammable fine plant litter fuels. In the absence of prescribed fire, fire intolerant hardwoods survive and grow to midstory or higher levels in the forest canopy. RCWs, being sensitive to midstory hardwood encroachment, will abandon their cavities and clusters due to hardwood encroachment (Conner and O'Halloran 1987; Costa and Escano 1989).

Recovery Criteria

Recovery criteria in the 2003 Recovery Plan have been formulated on the basis of 11 recovery units delineated according to ecoregions. Populations required for recovery are distributed among recovery units to ensure the representation of broad geographic, ecologic, and genetic variation in the species. The wide geographic distribution reduces the threat of catastrophic habitat destruction and population loss by hurricanes. The distribution of populations and recovery units also will facilitate periodic RCW immigration and emigration among populations, which will be required to offset or reduce the loss of potential adaptive genetic variation within populations by drift.

Population sizes identified in recovery criteria are measured as the number of potential breeding groups (PBG). A PBG is an adult female and adult male that occupy the same cluster, with or without one or more helpers, whether or not they attempt to nest or successfully fledge young. A traditional measure of population size has been number of active clusters. Potential breeding groups is a better measure of population status, because this is the basis of population dynamics in this species and number of active clusters can include varying proportions of solitary males and captured clusters. Estimates of all three parameters—number of active clusters, proportion of solitary males, and proportion of captured clusters—are required to support estimates of PBGs.

To assist in the transition between these two measures, a range of numbers of active clusters considered the equivalents of the required number of PBGs is provided. Estimated number of active clusters is likely to be at least 1.1 times the number of PBGs, but it is unlikely to be more than 1.4 times this number. Thus, an estimated 400 to 500 active clusters will be necessary to contain 350 PBGs, depending on the proportions of solitary males and captured clusters and also on the estimated error of the sampling scheme.

Each recovery unit consists of various designated primary core, secondary core, and essential support populations. Most populations reside on Federal lands, where the largest remaining populations tend to occur and the largest land base and resources for management are available. All or parts of each recovery population are on designated Federal, State, or private properties for management.

The 13 primary core populations consist of at least 350 PBGs, the 10 secondary core populations each have at least 250 PBGs, and the 17 essential support populations each have from 15 to 100 PBGs. As the largest populations, the primary core populations will be robust and viable against the threats of extirpation by demographic stochasticity, environmental stochasticity, and inbreeding depression. They are more likely to sustain genetic diversity and avoid adverse losses by genetic drift than smaller secondary core and essential support populations. Secondary core populations are of sufficient size to avoid inbreeding depression and are robust against demographic and environmental stochasticity. Essential support populations, the smallest, will remain potentially vulnerable to inbreeding and demographic and environmental stochasticity. The extent of this risk will depend on the density and aggregation and PBGs in each support population. Essential support populations will require more intensive long-term management, including RCW translocations.

Downlisting to threatened status will be considered when each of the following criteria is met.

Criterion 1. There is one stable or increasing population of 350 potential breeding groups (400 to 500 active clusters) in the Central Florida Panhandle.

This criterion has been met. The Apalachicola Ranger District, one of the five properties comprising the Central Florida Panhandle Primary Core population, harbors more than 350 PBGs.

Criterion 2. There is at least one stable or increasing population containing at least 250 potential breeding groups (275 to 350 active clusters) in each of the following recovery units: Sandhills, Mid-Atlantic Coastal Plain, South Atlantic Coastal Plain, West Gulf Coastal Plain, Upper West Gulf Coastal Plain, and Upper East Gulf Coastal Plain.

Three (Sandhills, Mid-Atlantic Coastal Plain, and South Atlantic Coastal Plain) of the six recovery units required to have a population with 250 PBGs are present.

Three (Sandhills, Mid-Atlantic Coastal Plain, and South Atlantic Coastal Plain) of the six recovery units required to have a population with 250 PBGs are present.

Criterion 3. There is at least one stable or increasing population containing at least 100 potential breeding groups (110 to 140 active clusters) in each of the following recovery units: Mid-Atlantic Coastal Plain, Sandhills, South Atlantic Coastal Plain, and East Gulf Coastal Plain. Note that these populations would be different from those required in Criterion 2 above.

This criterion has been met. Each of the listed recovery units contains at least one population (different from the populations listed under Criterion 2 above) that harbors at least 100 PBGs.

Criterion 4. There is at least one stable or increasing population containing at least 70 potential breeding groups (75 to 100 active clusters) in each of four recovery units, Cumberlands/Ridge and Valley, Ouachita Mountains, Piedmont, and Sandhills. In addition, the Northeast North Carolina/Southeast Virginia Essential Support Population is stable or increasing and contains at least 70 potential breeding groups (75 to 100 active clusters).

Only the Sandhills recovery unit contains a population harboring at least 70 PBGs (that would not be needed to satisfy either Criterion 2 or 3, which also require Sandhills populations of certain sizes).

Criterion 5. There are at least four populations each containing at least 40 potential breeding groups (45 to 60 active clusters) on State and/or Federal lands in the South/Central Florida Recovery Unit.

This criterion has not yet been met.

Criterion 6. There are habitat management plans in place in each of the above populations identifying management actions sufficient to increase the populations to recovery levels, with special emphasis on frequent prescribed burning during the growing season.

Although Criterion 6 is referring to the need for populations to have such plans when they achieve their size goals, the majority of the populations required for delisting already have management plans that address habitat management (e.g., prescribed burning) and population monitoring. These plans are generally updated at 5-year intervals. The plans take the form of Integrated Natural Resource Management Plans (military), Land and Resource Management Plans (U.S. Forest Service), Comprehensive Conservation Plans (national wildlife refuges), and property-specific State wildlife management area and forest land plans.

Delisting will be considered when each of the following criteria is met.

Criterion 1. There are 10 populations of red-cockaded woodpeckers that each contain at least 350 PBGs (400 to 500 active clusters), and 1 population that contains at least 1000 PBGs (1100 to 1400 active clusters), from among 13 designated primary core populations, and each of these 11 populations is not dependent on continuing installation of artificial cavities to remain at or above this population size.

One population (North Carolina Sandhills) of the 10 primary core populations required has achieved 350 PBGs but remains dependent on artificial cavities.

Criterion 2. There are nine populations of red-cockaded woodpeckers that each contain at least 250 potential breeding groups (275 to 350 active clusters), from among 10 designated secondary core populations, and each of these nine populations is not dependent on continuing installation of artificial cavities to remain at or above this population size.

None of the 10 secondary core populations harbors 250 PBGs.

Criterion 3. There are at least 250 potential breeding groups (275 to 350 active clusters) distributed among designated essential support populations in the South/Central Florida Recovery Unit, and six of these populations (including at least two of the following: Avon Park, Big Cypress, and Ocala) exhibit a minimum population size of 40 PBGs that is independent of continuing artificial cavity installation.

This criterion has not been achieved.

Criterion 4. There is one stable or increasing population containing at least 100 potential breeding groups (110 to 140 active clusters) in northeastern North Carolina and southeastern Virginia, the Cumberlands/Ridge and Valley recovery unit (Talladega/Shoal Creek), and the Sandhills recovery unit (North Carolina Sandhills West), and these populations are not dependent on continuing artificial cavity installation to remain at or above this population size.

One (North Carolina Sandhills West) of the three populations required to exceed 100 PBGs is present, although the population remains dependent on artificial cavities.

Criterion 5. For each of the populations meeting the above size criteria, responsible management agencies shall provide (1) a habitat management plan that is adequate to sustain the population and emphasizes frequent prescribed burning, and (2) a plan for continued population monitoring.

Although criterion 5 is referring to the need for populations to have such plans when they achieve their size goals, the majority of the populations required for delisting already have management plans that address habitat management (e.g., prescribed burning) and population monitoring. These plans are generally updated at 5-year intervals. The plans take the form of Integrated Natural Resource Management Plans (military), Land and Resource Management Plans (U.S. Forest Service), Comprehensive Conservation Plans (national wildlife refuges), and property-specific State wildlife management area and State forest plans.

Range-wide Trends

The decline of the RCW from the time of European settlement through the 1980s has been well documented and is directly related to loss and degradation of its old growth pine habitat (Figure 5). However, this range-wide decline has been halted and reversed. In the 1990's and through today, in response to intensive management based on a new understanding of population dynamics and new management tools, e.g., artificial cavities (Copeyon 1990; Allen 1991) and translocation (Costa and DeLotelle 2006), most public land populations and those private land populations in partnerships with the Service were stabilized and many showed increases.

Species-wide, the population trend of the RCW is increasing. In 1993/1994, the range-wide population was estimated at 4,694 active clusters; in 2006 it was 6,105 (Table 3). Of the 40 primary core, secondary core, and essential support recovery populations, 36 (90 percent) were either stable or increasing based on the average annual growth (number of active clusters) during the most recent 5-year growth period (2002-2007) for which data is available. Only four (10 percent) populations had a declining trend (Table 4): Central Florida Panhandle primary core (-0.1 percent), St. Sebastian River essential support (-3.0 percent), Three Lakes essential support (-0.7 percent), and Oakmulgee secondary core (-4.0 percent). The average annual percent growth of 16 (44 percent) of the 36 stable or increasing recovery populations met or exceeded the 5 percent annual growth objective in the recovery plan. Of the 11 recovery units, only the Upper East Gulf Coastal Plain had a net declining 5-year trend due to the declining population in the Oakmulgee Ranger District, Talladega National Forest (Table 4).

Although some recovery populations are composed of one of more properties (e.g., because the properties are adjacent to one another), most recovery populations (64%) are located on one property/ownership. The RCW Recovery Plan identifies 63 properties involved in recovery: 26 primary core, 14 secondary core and 23 essential support. At a property level as of 2007, 16 (25 percent) had a net 5-year declining trend (5) (Table 4).

Large recovery populations remain rare. Of the 63 recovery properties, only 6 (15 percent) exceed 250 active clusters (Table 5). Sixty-eight percent (10 populations) consist of less 100 or fewer active clusters, and 43 percent (9 populations) have less than 50 active clusters. The number of active clusters or PBGs on each property and designated recovery population occur at different densities and aggregations in response to the configuration of the property, available habitat, and the location of unsuitable habitat. RCW clusters and aggregations within and among properties may or may not actually represent a demographically functional RCW population under current conditions. Furthermore, some populations may remain subdivided at recovery. The extent that PBGs are spatially aggregated will affect population viability and persistence. Comprehensive spatial and GIS assessments of PBG aggregations, fragmentation, and population structure are not available for most properties and populations. However, several trends and patterns are evident. At least 10 of the 40 recovery populations are appreciably fragmented under current and likely future, conditions.

At least four primary core recovery populations are currently subdivided and likely will remain so at recovery (Table 6). The Central Florida Panhandle primary core population, the largest, is comprised of four properties (Table 4) where most RCWs reside in the Apalachicola Ranger District and Wakulla Ranger District of the Apalachicola National Forest (Table 6). The Wakulla RD and Apalachicola RD are separated by the Ochlocknee River and private lands, for a distance of least 5 miles that may limit RCW dispersal (James et al. 1997). PBGs in the two districts are highly unlikely to be demographically isolated, but demographic function may be compromised. If so, the Central Florida Panhandle primary core population at recovery, with at least 1000 PBGs, may function as one or more subdivided populations. Demographic and environmental stochasticity is not expected to pose any viability risk, but the ability of this recovery population to retain genetic variation will be less than anticipated.

The Eglin Air Force Base primary core population currently consists of two demographically separate populations on the east and west side of the Installation (Walters et al. 2004), which likely will remain independent at recovery. Thus, a single recovery population of 350 PBGs is expected to function as two smaller populations, with at least 100 PBGs in the smallest.

The Coastal North Carolina primary core recovery population consists of three separate properties; Croatan National Forest, Holly Shelter Game Lands, and Marine Corps Camp Lejeune. Because of the location and distance between these three properties, it is highly unlikely they will comprise a demographically functional, single population of 350 PBGs at recovery. Of the 380 total active-cluster management goals for these properties (Table 4), most of these goals are on Camp Lejeune (173 active clusters) and Croatan National Forest (169 active clusters).

The populations at Camp Lejeune and Croatan National Forest at recovery will each function with the attributes of at least an essential support population. RCWs at recovery on Camp Lejeune and Croatan National Forest, based on habitat and general future forecasts of cluster locations, should be mostly aggregated. This spatial arrangement will enhance population persistence, although the Camp Lejeune population and Croatan National Forest population will be more vulnerable to environmental stochasticity than that predicted from a single, relatively aggregated population of 350 PBGs.

The Sam Houston National Forest primary core population is fragmented by the pattern of Forest Service land ownerships and designated RCW habitat management areas (HMA). The 178 active clusters currently on the forest do not function as a single population. One designated HMA has a sufficient acreage to support 300-350 aggregated PBGs. Currently, PBGs are distributed among several fragmented HMAs.

The Bienville National Forest primary core population currently is fragmented as two or more smaller populations by land ownership patterns and habitat. At the recovery goal of 350 PBGs there will likely be two populations because of ownership and habitat, the smaller population with at least 100 PBGs.

The Angelina/Sabine National Forests primary core population is located on separate national forests, in at least five separate HMAs, significantly fragmented by reservoirs and land ownership patterns. The largest single HMA may support 180 active clusters. At recovery, this likely will consist of two populations, with about 150 PBGs each.

The Oakmulgee Ranger District, Tallahala National Forest secondary core population includes one tract of highly fragmented Forest Service land ownership. At recovery, this is not expected to demographically function as a single population of 250 PBGs.

The Conecuh National Forest/Blackwater State Forest secondary core population occurs on two separate properties, although in proximity to each other. However, SEPM indicates this also will function as at least two populations.

The Davy Crockett National Forest secondary core population is another fragmented property by ownership patterns and configuration. Of the 3 RCW HMAs, the largest may support up to 100 clusters. RCWs in each of the three HMA's likely will be separate populations depending on the habitat condition of non-federal properties.

The DeSoto National Forest secondary core population is designated for management on two separate HMAs, located at least 10 miles from each other. At recovery, there will be two separate populations instead of a single population with 250 PBGs.

An analysis of 2007 RCW data from 121 properties with RCWs submitting reports via the Annual RCW Report illustrates the status of the species at the property scale for recovery as well as populations not designated for recovery (Table 7). Although a few large populations exist on individual properties, most (74 percent) property populations are small, much more vulnerable populations of 50 or fewer active clusters.

In spite of the relatively small size of most populations, the status of RCWs has been consistently improving since the early 1990s (Table 3). This steady increase can be attributed to various factors, including aggressive prescribed burning programs, artificial cavity provisioning and regional translocation cooperatives and strategies (Costa and DeLotelle 2006). Implementation of these habitat and population management tools and techniques has successfully reversed the regional declines of the previous decades.

Time to recovery unit and population size objectives

Recovery criteria in the 2003 RCW Recovery Plan (U.S. Fish and Wildlife Service, 2003) was formulated on the basis of 11 recovery units, each with a designated number of primary core, secondary core, and essential support populations on specific properties managed by designated agencies (Table 1). There are 13 primary core populations each with at an objective of least 350 potential breeding groups (PBGs), 10 secondary core populations each with 250 PBGs, and 17 essential support populations with from 15 to 100 PBGs.

The Recovery Plan includes an estimate of the future time to for each designated recovery population to attain the size required for delisting (Recovery Plan Table 14). The future projection was based on several conditions:

- Habitat is not a limiting factor, with trees of a sufficient age and size for good quality foraging habitat and natural cavities, without dependence on artificial cavities in the absence of recovery management;
- All populations grow at the minimum recommended plan rate of 5 percent average annual growth of active clusters or potential breeding groups (PBGs); and
- The ratio of active clusters to PBGs is 1.4:1.

The Recovery Plan does not specify an objective for the time of recovery. Instead, the Recovery Plan objective is that populations grow at an average annual rate of 5 to 10 percent to reach their recovery size objective. The future time at which recovery populations and units attain their size objectives is an inherent objective as a consequence of the recommended population growth rates.

The future time of recovery is important because it reflects the size and growth of populations at different intervals. RCW population size is a critical factor affecting the ability of a population to withstand adverse effects of inbreeding and stochastic demographic, environmental, genetic, and catastrophic factors. Adverse effects of reduced population growth rates and prolonging recovery will depend on the particular population affected, as well as the status and vulnerability of other populations. This is because RCW recovery ultimately depends on the establishment of populations in recovery units throughout most of the historic range of the species. This geographic arrangement not only reduces range wide impacts from catastrophic recurring hurricanes, but is intended to facilitate sufficient immigration and emigration among populations to avoid adverse effects of genetic drift.

Forecasts of the time to reach population size objectives in the 2003 Recovery Plan have been modified by a different procedure and updated using the best available population size data (active clusters) for 2007. The modified procedure is described in Appendix C with additional status information. It involves four differences compared to the 2003 Recovery Plan procedure. First, number of PBGs are estimated by a 1.12:1 active cluster to PBG ratio (89% PBGs), instead of 1.4:1 (71% PBGs) as in the Recovery Plan. Second, forecasts of growth are made for property-populations where designated recovery populations consist of multiple properties. Third, the average annual percent geometric growth depends on the RCW population size-class. Finally, the size of initial populations is based on more recent 2007 data.
The 2003 Recovery Plan forecasted 2075 as the year when all recovery units had reached their respective population size recovery objectives. The updated forecast for all recovery units is 2085 (Tables 9 and 14). The longer interval mostly reflects updated estimates based on projected growth of property-populations for recovery populations consisting of multiple properties. It does not reflect any range wide or significant overall declining population trend.

Recovery unit population size objectives are the total number of PBGs from the constituent populations and their objectives. None of the 11 designated recovery units have attained their recovery size objectives. The Sandhills Recovery Unit (RU) is forecast to be the first RU to attain all population size objectives in 2024. However, significant future habitat limitations are expected in the Fort Benning Primary Core population in response to forest decline syndrome, mostly by off-site loblolly pine senescence and death. Adverse effects of forest decline will delay recovery in the Sandhills RU, as discussed in later sections.

The South/Central Florida RU probably will be the first RU to attain size objectives in 2026. This unit consists of 13 essential support populations, many of which have or will soon attain size objectives. This unit consists solely of essential support populations. Compared to other essential support populations, most of these are smaller with objectives ranging from 15 to 40 PBGs. Most of the populations are managed by Florida state agencies, and all are well managed.

The East Gulf Coastal Plain RU is forecast as the last unit to attain recovery size objectives in 2085 (Table 14). Although its constituent Eglin Primary Core population is on the verge of reaching its objective of 350 PBGs by next year, the small Chickasawhay Primary Core population will require about 78 years of growth to reach 350 PBGs in 2085. Similarly, the DeSoto Secondary Core population isn't expected to reach its objective until 2072. Both of these small populations are in the DeSoto National Forest. The Central Florida Panhandle Primary Core population will be the largest single recovery population, with 1000 PBGs, by about 2078.

Following the South/Central Florida RU are the Mid-Atlantic Coastal Plain RU (2041), Upper West Gulf Coastal Plain RU (2042), West Gulf Coastal Plain RU (2053), Cumberlands/Ridge and Valley RU (2057), Piedmont (2057), South Atlantic Coastal Plain RU (2064), Upper East Gulf Coastal Plain RU (2066), and Ouachita Mountains RU (2067)(Table 14).

Apart from recovery units, nine recovery populations have either attained their size objective or will likely reach goals during this decade (Table 13). Most of these first populations expected are the smaller essential support populations in the South/Central Florida RU. This includes the North Carolina Sandhills East Primary Core Population, which was the first primary core population to attain its objective. Population management by Fort Bragg and private properties secured for RCW recovery management by Army and conservation partners achieved this primary core objective. The North Carolina Sandhills East population is not tabulated as having attained its size objective (Tables 9, 13 and 14) because population growth did not account for these other private properties.

During the 78-year interval from 2007 to 2085, 64 percent (25) of the 39 designated recovery populations are forecast to reach their size objectives midway (39 years, 2046) through this period. Eight of the 13 primary core populations are attained by this midpoint, but the entire period until 2085 is required for all primary core populations to reach objectives. Primary core populations will be the largest, most stable core recovery populations, which are important for early establishment. During the next decade, four primary core populations are expected: North Carolina Sandhills East, Eglin, Francis Marion, and Fort Stewart (Table 13). With the exception of large interior primary core populations, recovery populations which attain their size objectives during this 78-year period are geographically distributed in a fairly wide pattern. Interior populations inland of the Atlantic and Gulf Coastal Plain are much less likely to be catastrophically affected by hurricanes. However, most interior primary and secondary core populations do not reach recovery size objectives until the latter half of the 78-year population growth period.

Relict Trillium

Biology

A perennial herbaceous member of the lily family, relict trillium is distinguished from other sessile-flowered trilliums by its decumbent or S-curved stems, distinctively-shaped anthers and shape of its leaves. Greenish to brownish purple and yellow flowers appear in early spring and the fruit is an oval-shaped, berry-like capsule which matures in early summer. After the fruit matures, the plant dies back to a tuberous rhizome (Patrick et al. 1995; USFWS 1990). Relict trillium is found in South Carolina, Georgia and Alabama in mature, moist, undisturbed hardwood forests that are usually fire-suppressed and in alluvial sands to rocky clays with a high organic content in their upper layer.

Genetics

The recovery plan was developed without benefit of information on the population genetics of relict trillium. However in a recent study on the distribution of genetic diversity among disjunct populations of relict trillium, Gonzales and Hamrick (2005) concluded that there is currently no appreciable gene flow among relict trillium populations and that historically there was little genetic interchange between populations. They contend that the rarity and isolated populations characteristic of the species are of ancient origin rather than due to recent habitat fragmentation following European colonization. Specifically, Gonzales and Hamrick (2005) results also suggest that the Alabama and Georgia populations, separated by the Chattahoochee River acting as an effective barrier to genetic interchange, may represent different historical lineages, perhaps originating from separate glacial refugia on opposite sides of the Chattahoochee River. They recommend that the number and distribution of protected populations necessary for downlisting or delisting should be re-evaluated to determine the number and distribution required to preserve the genetic variability of the species.

Summary of Threats

State laws and regulations in Alabama, Georgia, and South Carolina do not provide protection for relict trillium habitat on private land (GADNR 2006; USACE 2008). Since the Act provides very limited protection for listed plants and their habitat on non-Federal land, most populations are at risk from development and other land use changes. The majority of populations in Alabama and Georgia have not been visited by biologists in several years and their current condition is unknown (USACE 2008).

The primary factors negatively affecting relict trillium that justified listing and were described in the recovery plan have not abated. Human population growth within the range of relict trillium has been increasing since 1990 (U.S. Census Bureau 2006a) and is expected to continue through at least the year 2020 (U.S. Census Bureau 2006b). With this trend, human encroachment continues to fragment, degrade and destroy habitat.

Since most populations are not monitored on an annual basis, it is not known how many populations range-wide are at imminent risk from development or timber harvest. Since 2004, two populations are known to have been damaged or reduced in size by development, road construction and timber operations (USACE 2008). In another example, negotiations were completed (2006) between TNC and two timber companies to minimize damage to one Georgia population and one Alabama population that are scheduled to be clear cut (USACE 2008). The Nature Conservancy is also actively pursuing conservation easements for private lands that have relict trillium populations.

No diseases, insects, or herbivores were mentioned as a concern in the recovery plan. Species subsequently reported as detrimental to relict trillium include high populations of white-tailed deer in Georgia and South Carolina and an as yet unidentified cutworm (Lepidopteran moth larvae) affecting populations in South Carolina (USACE 2008). Methods of dealing with white-tailed deer damage include exclusion fencing and increasing deer hunting to reduce the deer population. The lack of reported deer damage at locations that have an effective deer hunting program, such as Ft. Benning, may indicate that relict trillium is not a preferred food but is acceptable when high density deer populations reduce the availability of preferred plants.

Moule (SCDNR, pers.comm. 2006) reported that there has been a decline in the Savannah Bluffs population he believes is due to the unidentified cutworm. No management strategy to deal with cutworms has yet been developed and the long-term implications of cutworm damage are unknown (Moule, SCDNR, pers. comm. 2006). Feral swine are also a concern because of their intensive rooting activity. While it is not known to what degree swine target relict trillium rhizomes for food, their extensive rooting may damage or uproot trillium. It is also not known how long it may take for populations to recover from hog rooting.

One disease affecting relict trillium has been reported recently. Gyer (2005) observed diseased specimens at one of the Ft. Benning, Georgia populations. Plants had lesions on the leaves apparently caused by the fungus (*Ciborinia trillii)* as tentatively identified by Dr. Lori Carris of Washington State University.

Exotic invasive plants pose threats to trillium populations through competition for space and nutrients; the recovery plan mentions honeysuckle (*Lonicera japonica*) and kudzu (*Pueraria lobata*). Honeysuckle can be controlled with applications of the herbicide glyphosate (Heckel and Leege 2004; Thornton 2005) and is especially useful after senescence of relict trillium stems and leaves. Another plant that is a range-wide concern is privet (*Ligustrum spp*.). Common chickweed (*Stellaria media*) is a concern at one site in Georgia (USACE 2008). Chickweed grows and sets seed during the early spring when relict trillium is actively growing above ground and most susceptible to herbicide, which could make control by herbicide more difficult. These invasive species may be found in relict trillium habitat singly or in various combination and densities, complicating suppression efforts.

Fire, either wild or prescribed, was recognized in the recovery plan as a threat to relict trillium, based on habitat requirements of hardwood overstory and a thick duff layer. A burn during the spring when relict trillium is actively growing and flowering could be especially harmful, eliminating reproduction and reducing transfer of nutrients to the rhizomes. Fire during other times of the year would reduce or eliminate the duff layer and could destroy trillium seeds.

One population on Ft. Benning was burned in a wildfire during the spring of 2003, destroying the vegetative parts above ground. Annual monitoring showed an almost complete recovery from the burn effects by the spring of 2006 (USACE 2008) indicating that relict trillium populations may recover from infrequent fires when given enough time between fires to rebuild energy stores and recover the habitat.

Recovery Goals

Priority recovery goals described in the species' recovery plan (USFWS 1990) include, but are not limited to: (1) determining habitat protection priorities and developing landowner agreements, (2) planning and implementing necessary management techniques, (3) defining the criteria for what constitutes a self-sustaining population and determining the size of area each population needs to be self-sustaining, (4) re-establishing populations within suitable habitat and, (5) maintaining a cultivated source of plants and providing for long-term seed storage.

Status and Distribution

Relict trillium has proven to be more abundant than was realized when the recovery plan was written. There were 21 known populations in 1990 consisting of locations in three, two, and six counties in Alabama, South Carolina and Georgia, respectively (USFWS 1990). The number of counties with known populations has not changed in Alabama and South Carolina but has more than doubled, to 16, in Georgia (USACE 2008).

As of 2006, there were at least 60 populations with other reported occurrences yet to be confirmed (USACE 2008). Although, there is no organized effort to monitor trends in all known populations, there is little evidence that these populations are expanding in range or number; however, populations are being found for the first time. This is likely attributed to an increased interest in the plant and increased botanical surveys on Federal and State lands.

Annual sampling has been conducted at Ft. Benning, Muscogee County, Georgia and the Savannah River Bluffs Heritage Preserve in Aiken County, South Carolina. Population trends on Ft. Benning are monitored annually by counting the plants in five permanent plots in each of five populations.

The Savannah River Bluffs data for 2004 showed a total of 2,805 plants and increases in the number of plants flowering of 1.7% over 2003 and 3.6% over 2002. Above normal rainfall in 2003, preceded by several years of drought, was the likely reason for an increase in flowering (USACE 2008). Moule (SCDNR, pers.com., 2006) reported a decline in the Savannah River Bluffs population; whereas, the status of other South Carolina populations was unknown.

There has not been a range-wide attempt to systematically survey potential habitat for relict trillium. Some Federal and State lands have been systematically surveyed and TNC has searched selected private holdings in Alabama and Georgia, finding three additional populations in recent years (USACE 2008). The Service's 2008 recovery data call has relict trillium currently in a stable status.

There are two criteria considered for the removal of the relict trillium from the Federal list of endangered species (USFWS 1990):

1) It has been documented that at least 12 populations (2 in Alabama, 7 in Georgia, and 3 in South Carolina) are self-sustaining and occur on sufficiently large tracts to ensure their perpetuation with a minimal amount of active management.
2) All of the above populations and their habitat are protected from present and foreseeable human-related and natural threats that may interfere with the survival of any of the populations.

A self-sustaining population is a population of 500 or greater individuals (Hamrick, GDNR; Imm, SERL pers. comm. 2009). Site integrity and quality combined with conservation status are also important criteria for sustainability (M. Elmore, TNC, pers. comm., 2009). Within the 63 reported occurrences in Georgia, seven occurrences meet the criteria of being self-sustaining populations on sufficiently large tracts which ensure their perpetuation with a minimal amount of active management. In Georgia, one site is privately owned but the family has a landowner agreement with TNC (estimated 1000 plants), a second site occurs on the Oconee National Forest (estimated 50,000 plants), and three sites occur on Fort Benning (each with more than 500 plants). In Alabama one site (estimated 25,000 plants) is owned by the Army Corp of Engineers and in South Carolina one site (approximately 3,000 plants) is owned by the State. It is anticipated that the size and ownership of these seven occurrences would provide sufficient protection to meet the recovery criteria. However, additional protection such as landowner agreements may be required to achieve recovery.

ENVIRONMENTAL BASELINE

The environmental baseline includes the past and present impacts of all Federal, State, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal section 7 consultation, and the impact of State or private actions which are contemporaneous with the consultation in process (50 CFR § 402.02).

Background

September 1994
The Service issued a BO to Ft. Benning (USFWS 1994). The BO concluded that ongoing military training and related activities at Ft. Benning jeopardized the continued existence of the Installation's RCW population. The reasonable and prudent alternative included increasing the number of RCW personnel, now 38, and improving management activities.

September 2002
The Service issued a BO based on the review of the Installation's RCW Endangered Species Management Plan (ESMP) (Ft. Benning 2002, USFWS 2002). The 2002 BO required ongoing management activities that were non-discretionary, including burning 90,000 acres of current and potential RCW habitat on a return interval of three years; repairing and preventing soil erosion in clusters; coordinating a training area inspection process incorporating natural resources personnel; and reducing fuel around cavity trees. Additionally, the 2002 BO on the ESMP considered training activities and its approval as the catalyst that allowed the Installation

to adopt the Army's 1996 Management Guidelines for the RCW (USDOA 1996) and gave the Installation incidental take coverage for 41 known clusters in the A20 Impact Area.

July 2004
The Service issued a BO to the Installation for the construction, operation and maintenance of a Digital Multi-Purpose Range Complex (USFWS 2004). The project removed approximately 1,500 acres of upland pine habitat and wetlands. The BO concluded that jeopardy was not likely and seven PBGs were included in the incidental take statement (ITS). The ITS required activities to manage and monitor the seven PBGs that would be impacted as a result of the action, monitor RCW habitat that may degrade as training activities are implemented, and continue to protect cavity trees in all seven clusters during all stages of the project. Shortly after completion of the consultation, an inactive cluster became active and was included in the ITS so that a total of eight PBGs were expected to be incidentally taken by the action (USFWS 2006b).

August 2007
The Service issued a BO for the construction, operation and maintenance of Transformation actions, to include Base Realignment and Closure, Global Defense Posturing and Realignment, Army Modular Force and other stationing actions. Pre-project, the Installation managed roughly 86,000 acres of pine habitat for RCWs. Post-project, the remaining acreage roughly totaled 74,700 acres, of which 21,400 acres were in loblolly or shortleaf pine stands that were determined to be in high risk for pine decline syndrome. The BO concluded 32 PBGs would be included in the ITS, and that the project would not jeopardize continued existence of the species. Within weeks of completion of the consultation, the Army notified the Service that the BRAC project was being modified and would be mostly realigned into the MCOE. All the components and the expected incidental take were reassessed. Many of the components were deleted. Once the original BRAC project was re-configured, only eight PBGs were included in the original ITS.

Status of Red-cockaded Woodpecker within the Action Area

Cluster Inspections and Management. Since 1994, RCW population demographics have been intensively studied, resulting in an extensive RCW population database. Of 307 clusters Ft. Benning managed in 2008, 284 were active clusters. The managed clusters include all clusters on the Installation with the exception of inaccessible clusters in dudded impact areas (manageable clusters within impact areas are included in the 307 total). The 307 managed clusters include the eight clusters that were included in the DMPRC incidental take statement (USFWS 2004, Ft. Benning 2005, USFWS 2006c) and 32 clusters, reduced to eight after reanalysis, that were included in the BRAC incidental take statement (USFWS 2007). Enough demographic data is collected at each managed cluster to determine the presence or absence of a PBG. Managed clusters inhabited by a PBG can be counted toward the Installation's RCW population goal (USDOA 1996, 2007) if they are not included in an ITS.

All managed clusters are inspected every spring (March-April) and recruitment clusters are inspected again in the fall (September-October). During cluster inspections, RCW biologists and technicians record comprehensive data about the cavity trees, habitat within the cluster area and overall management concerns. Any new cavity or start trees found during nesting season are marked and entered into the RCW database (Ft. Benning 2002, USDOA 1996).

Cavities are maintained or artificial cavities are installed as needed to provide each managed cluster with at least four suitable cavities, per the 1996 Guidelines (USDOA 1996). Cluster areas are managed mechanically and/or chemically as needed to keep the cluster area free of midstory (hardwood or pine) (Ft. Benning 2002).

Demographic Monitoring. Ft. Benning also monitors and color-bands RCWs in at least 25% of all active clusters on the Installation (65 clusters). Color-bands are unique combinations of colored leg bands that identify each RCW individual. As the population increases, more clusters are added to maintain a 25% sample (Ft. Benning 2002, USDOA 1996). The 1996 Guidelines (USDOA 1996) also require monitoring recruitment clusters for five years after becoming active. Recruitment clusters are unoccupied clusters provisioned with artificial cavities in close proximity to active clusters, where habitat is provided to induce the formation of a new RCW groups and to increase the population. Ft. Benning currently monitors RCWs at 84 recruitment clusters on the Installation, regardless of how long they have been active. RCWs at an additional 30 clusters have been monitored since 2003 as a follow-up to the DMPRC (Ft. Benning 2004b), and 16 more have been added as a follow-up to BRAC, resulting in a total of 61% (188) of all 307 managed clusters being monitored for potential banding. In 2008, 17 of the 188 total clusters monitored for potential banding were inactive. Activities at clusters where banding occurs include banding all nestlings and adults, identifying previously banded adults, determining fledgling success and determining the sex of fledglings (Ft. Benning 2002, USDOA 1996).

Recruitment Clusters. According to the 1996 Guidelines (USDOA 1996), Installations must add recruitment sites, within the limitations of available habitat, to achieve at least the optimum rate of population growth so as to meet individual population goals. Recruitment clusters created for this purpose are managed as primary recruitment clusters (PRCs) and are subject to the same training restrictions and protection as natural/preexisting RCW clusters (USDOA 1996). In 2008, Ft. Benning had 104 clusters designated as PRCs and 85 were active.

Additionally, supplemental recruitment clusters (SRC) must be created, as available habitat allows, above and beyond the required number of PRCs. SRCs are not subject to any training restrictions and are "invisible to training" (trees are painted less conspicuously than PRCs), therefore they require an incidental take statement. All SRCs were included in the incidental take anticipated for implementation of the ESMP (up to 15 groups) (USFWS 2002). This level of take applies only to training impacts; no construction activities can be undertaken in these areas without additional consultation with the Service. In 2008, Ft. Benning had eight clusters designated as SRCs, all of which were active. When RCWs voluntarily move into a stand not previously designated as a recruitment site, the new cluster is designated as either a PRC or SRC depending on the military use of the area (USDOA 1996).

The Recovery Plan recommends a 5% average annual population growth in all RCW populations, to be achieved by providing a number of unoccupied recruitment clusters equal to 10% of the total number of active clusters (USFWS 2003, USDOA 2007). In 2008, Ft. Benning had ten unoccupied recruitment clusters with four suitable cavities each, which is 3.5% of the number of active clusters on the Installation (284) (USACE 2008). Ft. Benning is limited in the areas that are suitable for new recruitment clusters due to a variety of management challenges (e.g., potential recruitment stands are too young and limitations on access to habitat).

Clusters within the A20 Impact Area. The BO on the 2001 RCW ESMP (USFWS 2002) provided an ITS for 41 groups in the A20 impact area (29 known clusters and an estimated 12 unknown groups) (Figure 6). RCW groups in three other clusters could be managed by Ft. Benning and were not included in the ITS (USFWS 2002). As part of the DMPRC BO, an additional 11 clusters within the A20 Impact Area were brought under management (USFWS 2004, 2006c) to offset eight clusters expected to be lost when the new range is active. The eight clusters covered by the DMPRC ITS cannot be counted toward Ft. Benning's recovery goal until five years after training on the range begins. The five years provides time for Ft. Benning and the Service to observe impacts to the clusters. If the eight clusters are not lost, Ft. Benning will be able to include the 11 clusters toward their recovery goal. FBCB is able to access these clusters four days per year per an agreement with FBRD, including at least one visit during the nesting season to document breeding status.

In 2008 and 2009, Ft. Benning personnel conducted ground and aerial surveys to assess the status and accessibility of RCW clusters within the A20 impact area to count them toward Ft. Benning's recovery goal. The results of the survey revealed 46 clusters, of which 32 were previously unknown. In total, 65 active clusters were identified, of which 22 clusters will be monitored, managed, and counted toward recovery. The 22 clusters include the 14 currently monitored, and eight that were shown to be accessible.

Population Growth. The first comprehensive cluster inspections were completed between 1990 and 1992, although cavity trees have been marked with white paint since 1980 and have had metal numeric tags since 1982. The extent of information gathered was limited by today's standards, but the 1990-1992 data revealed 171 active and 57 inactive clusters. When monitoring began in 1994, there were 174 active clusters (Doresky et al. 2004). In July 2008, the number of managed clusters had increased to 307, consisting of 271 PBGs, 1 solitary RCW, 5 captured clusters and 23 inactive clusters (FBCB unpub. data, 2008) including clusters that are part of current incidental take statements. The Ft. Benning RCW population showed a 2.5% increase in active clusters and a 3.4% increase in the number of PBGs between 2007 and 2008. Since 2003, the RCW population has shown steady growth and averaged 2.5% increase in active clusters and 4.1% increase in the number of PBGs per year (FBCB unpub. data 2008).

Surveys. Surveys for new RCW cavity trees on Ft. Benning are scheduled so that 100% of potential RCW nesting habitat on the Installation is surveyed every 10 years or 10% of the Installation is surveyed each year (USACE 2008). To fulfill survey requirements for BRAC and MCOE actions, surveys from 2006 to date have been targeted to the areas potentially impacted by proposed projects. Additionally, prior to any timber harvest or significant land-disturbing activity, the project site and a 0.5-mile radius around it are surveyed for new cavity trees. As new cavity trees are marked, cluster buffers are adjusted according to their level of protection (natural cluster, PRC or SRC) (USDOA 1996).

Translocation. Ft. Benning is a participant in the Service's RCW Southern Range Translocation Cooperative (SRTC). Since 1998, Ft. Benning has donated 10-16 juvenile RCWs per year to supplement other RCW populations (USDOA 2008). In 2007, Ft. Benning donated three pairs of hatching-year RCWs to the Chickasawhay Ranger District, DeSoto National Forest, Mississippi and three pairs and one hatching-year male to Enon Plantation, Alabama, a private quail plantation that was recently enrolled in the Alabama Safe Harbor Program. Prior to the establishment of the SRTC, Ft. Benning also donated one bird to the Daniel Boone National Forest, Kentucky.

Role of Ft. Benning in RCW Recovery. Ft. Benning's RCWs population is designated as 1 of 13 primary core recovery populations by the Service (2003). Primary core populations by definition will contain at least 350 PBGs at recovery (USFWS 2003). Based on average percentages of clusters inhabited by PBGs or solitary males and those clusters that are captured by a neighboring RCW group or inactive, Ft. Benning currently needs to manage 421 clusters to meet its recovery objective of 351 PBGs. As part of the minimization for the 1998 Land Exchange, the Army committed to supporting one additional PBG at Ft. Benning for recovery.

The Ft. Benning RCW population is part of the Sandhills Recovery Unit, which is a narrow land formation stretching from Ft. Benning northeast to just north of the Fort Bragg Military Reservation in North Carolina (Figure 7). Recovery units are distinguished by, and named for, the ecoregions in which they fall. Ecoregions are classified by physiographic characteristics such as land formation, climate, air and sea currents and distribution of species. According to the recovery plan, RCW recovery units are likely environmental surrogates for genetic variation, adaptation, and a response to local environmental conditions. By conserving the RCW in each of its natural ecoregions, most of its genetic variation will be preserved. Maintaining populations in all ecoregions is crucial for the long-term viability of the species (USFWS 2003).

Ft. Benning currently has the 6th largest RCW population and is one of three inland primary core recovery populations (see Table 6). Of these three (Ft. Benning, Ft. Bragg, and Bienville National Forest), Ft. Benning is the most insular primary core population, located about 180 miles inland. As stated earlier (see Status of the Species), inland populations are critical to species recovery because of the susceptibility of the 10 coastal populations to hurricanes. Additionally, maintaining the Ft. Benning primary core recovery population is important to the recovery strategy of a series of populations stretching across the species' range such that natural dispersal among these populations is possible, reducing adverse effects of genetic drift, once the species is recovered. Furthermore, one of the three, the Bienville primary core population in Mississippi, will not likely function as a demographically single population because of land ownership patterns.

While some core populations are comprised of RCW groups on multiple ownerships and locations within a geographic area, the nearest off-property RCW recovery population to Ft. Benning is approximately 78 miles east northeast of Columbus at the Piedmont National Wildlife Refuge/Oconee National Forest (Secondary Core) (USFWS 2003). In the 13 years of monitoring at Ft. Benning, only four dispersals have been documented from off-Post: one from the Piedmont National Wildlife Refuge/Oconee National Forest population, one from Fort Gordon (approximately 170 miles) and, in 2008, two from the Silver Lake Tract, which was recently acquired by Georgia Department of Natural Resources as part of Southlands Forest (approximately 100 miles) (USACE 2008). In addition, one RCW that was banded on Ft. Benning dispersed and was observed on the Enon-Sehoy Plantation in 2008.

To be considered a genetically connected population, 1-10 immigrants are needed per generation (approximately four years for RCWs) (Reed et al. 1988), each way, in order to be sufficient to prevent loss of genetic polymorphism and heterozygosity within subpopulations (Mills and Allendorf 1996; Walters et al. 2004). Birds that have moved must survive to breed successfully. Because of the lack of significant exchange of genetic material between Ft. Benning RCWs and clusters off the Installation, Ft. Benning is the sole landowner contributing to the aptly named Ft. Benning primary core Population.

There are also four known active RCW clusters on Enon Plantation and two active clusters on Sehoy Plantation, which are 20-30 miles west of Ft. Benning. These properties do not have a recovery role defined in the Recovery Plan and will therefore not contribute to the species' downlisting and delisting (USFWS 2003). However, portions of these properties will be protected in perpetuity and are enrolled in the Alabama RCW Safe Harbor Program. The Army, Service, TNC and other organizations have a common interest in preserving undeveloped land between Ft. Benning and Enon/Sehoy Plantations to increase the long-term stability of the Ft. Benning population. The logistics and details of this initiative, such as feasibility of landowner incentives for endangered species management on private lands, are currently being discussed by the above-listed organizations.

Factors Affecting RCWs Within the Action Area.
Longleaf pine is the natural and dominant pine forest and community type of the Fall Line Sandhills ecoregion (e.g. Peet and Allard 1993; Georgia Department of Natural Resources 2005), which includes a substantial part of Ft. Benning. Historical records show that up to 75% of Ft. Benning was cleared of timber prior to 1920. The Installation continued to be subjected to extensive timber harvesting throughout the 20th century (Doresky et al. 2004). From the 1930s to the 1970s, measures were taken to rehabilitate eroded areas, including widespread planting of loblolly pine; these trees have become the primary source of RCW cavity trees and foraging habitat on the Installation (Ecological Society of America and SEMP 2008). Past agricultural use, logging operations, the planting of off-site, loblolly and slash pine and fire suppression have left Ft. Benning with a relatively young pine forest. Installation-wide, the average pine stand is approximately 45 years old, highly fragmented by military development and, in some areas, is dominated by large, even-aged pine plantations (FBLMB, unpub. data, 2008).

According to the Installation's ESMP, all acreage on the Installation that is managed for RCWs is scheduled for burning on an average 3-year fire return interval (Ft. Benning 2002). As of October 2008, Ft. Benning burned 28,483 acres of pine-dominated habitat in 2008, 13,532 acres of which were burned during the growing season (USACE 2008).

In 2003, stands dominated by loblolly pine were estimated to comprise approximately 70% of the pine stands greater than or equal to 30 years old at Ft. Benning (Doresky et al. 2004). Under baseline conditions (including only BRAC projects not being analyzed for MCOE), approximately 38.5% (27,018 of 70,256 acres) of the pine stands greater than or equal to 30 years old were dominated by loblolly pine or mixed pine and 33.3% (23,395 of 70,256 acres) were longleaf pine, 2.0% (1,439 of 70,256 acres) were shortleaf or slash pine and the remaining 18,404 acres (26.2% of 70,256 acres) did not have a pine species specified. Conversely, as a result of Ft. Benning's efforts to restore longleaf pine, 79.7% of the pine acreage less than 30 years old is planted longleaf pine (14,685 of 18,419 acres) (USACE 2007b; FBLMB, unpub. data, 2008).

In 1993, TNC reported that there were 1,807 RCW cavity trees on Ft. Benning: 1,303 loblolly pines, 424 longleaf pines and 80 shortleaf pines (TNC, unpub. data, 1993). Data collected in 2008 by FBCB personnel documented 2,791 RCW cavity trees: 1,469 loblolly pines, 1,260 longleaf pines, and 62 shortleaf pines. These data show a large increase in the number of longleaf pines with RCW cavities from 1993 to 2008 (from 23.4% of all cavity trees to 45.1%). This is mainly due to the provisioning of artificial cavity inserts and drilled cavities; 50% of all cavities are inserts or drilled. In 2008, there were 931 trees with artificial cavities. Of these, 817 (87.8%) were in longleaf pines. Additionally, 455 of 1338 (34.0%) of all active cavities were artificial, indicating the positive role that artificial cavities have had upon the population (USACE 2007b; FBCB, unpub. data, 2008).

A notable decline in forest health has been documented on Ft. Benning since 1994, according to data collected using the US Forest Service Forest Inventory and Analysis and Forest Health Monitoring protocols, as well as crown vigor data collected during periodic stand inventories. In addition, the mortality rate of RCW cavity trees has increased significantly since 2000 (Imm et al. 2008). Observations on Ft. Benning have documented declining pine forest health (less than 25% trees with "good" canopy crown condition) and increased pine mortality (3 to 5 fold increase since 1990's).

Ft. Benning contains the largest RCW population strongly reliant on off-site loblolly pines (Doresky et al. 2004). Research and observations indicate, however, that loblolly pine may not be well-suited for long-term production in the Ft. Benning area. The properties where loblolly decline has been observed are primarily public properties where primary management goals are resource conservation and not commercial timber production. Commercial timber companies typically manage loblolly pine on a short rotation and trees are harvested before they reach the age when decline symptoms would occur. It is possible that, given the history of soil erosion, soil compaction and disturbance on Ft. Benning, it may not be possible for loblolly pine stands to reach maturity in sufficient densities to provide suitable nesting or foraging habitat for the RCW. According to the Ecological Society of America (ESA) and SEMP report (2008), the decline of loblolly at this age and size on these sites may thus be entirely predictable and normal, with few proven measures to prevent it.

A potential RCW population bottleneck could occur if the loss of mature loblolly pines for cavities and foraging exceeds the replacement rate from longleaf regeneration (Doresky et al. 2004; ESA and SEMP 2008). In 1994, Ft. Benning began regenerating longleaf pine on all appropriate sites. Approximately 1,000 acres have been planted annually in longleaf pine since 1995, with approximately 1,250 acres in 2006, 1,285 acres in 2007 and 1,629 acres in 2008 (as of August) for a total of 16,516 acres planted to date (FBLMB, unpub. data, 2008). This has been accomplished by clear-cutting and converting unhealthy/unproductive off-site pine stands and by thinning mature off-site stands and under-planting with longleaf pine. Approximately 2,926 acres of the total have been under-planted with longleaf pine. Of the 16,516 acres planted in longleaf , approximately 3,574 acres have been or will be permanently cleared for BRAC and other approved projects, leaving 12,942 acres (FBLMB, unpub. data, 2008).

The majority of observations of pine decline have been in the Sandhills physiographic region, near the interface of the Piedmont province and either the East Gulf Coastal Plain or the Atlantic Coastal Plain physiographic regions. Symptoms are most common in mature loblolly pine and in mature mixed loblolly and shortleaf pine stands; however, symptoms have been reported in longleaf stands as well. Most reported occurrences have involved off-site, planted pine stands that are greater than, or equal to, 50 years old and/or stands planted in high densities (ESA and SEMP 2008).

Pine decline symptoms are similar to, and have been mistaken for, natural senescence and littleleaf disease, the latter caused by at least two soil-born fungi, *Phytophthora cinnamomi* and *Pythium* sp. Symptoms include progressively thinning crowns, reduced crown vigor, reduced radial growth, root deterioration and premature death (Eckhardt et al. 2004; ESA and SEMP 2008). Symptoms generally appear between 30 and 50 years of age, with subsequent death at greater than or equal to 50 years of age (ESA and SEMP 2008), but have been observed in younger stands (Eckhardt et al. 2004).

To help predict areas which are most susceptible to decline, in 2004, researchers from Louisiana State University Agricultural Center completed a model that weighed factors that have been associated with decline, including slope and aspect. One product of this work was a "Loblolly Decline Risk Map" containing a Geographic Information Systems (GIS) layer that shows the areas on Ft. Benning which, if forested with loblolly or shortleaf pine, are at high, moderate, low or minimal risk of decline (Figure 8). Disturbance greatly increases the chances of decline, specifically in the moderate and low risk zones. Loblolly or shortleaf stands can be productive in these zones if disturbance is minimized.

The best available science indicates pine decline is caused by a combination of factors that alone would typically not cause mortality. These factors include pathogens, insects, site factors, age and stress (Eckhardt 2005; ESA and SEMP 2008). These components are often present in healthy stands without ever causing decline symptoms. When trees are weakened by a disturbance, this can create an environment that is conducive to the insect vector and that is vulnerable to the pathogen, thereby triggering a decline in tree health from which trees do not recover (Eckhardt 2005). Disturbance, as pertaining to pine decline, can be categorized as anthropogenic (silvicultural (e.g. logging, prescribed fire)), recreational or training activities (e.g., heavy maneuver), or natural (e.g., weather, drought) and affects tree health by damaging the roots, bole or crown and/or compacting the soil (impacting hydrology and nutrient absorption).

The primary pathogen associated with symptoms of loblolly decline in particular is one or more species of vascular stain fungi (*Leptographium* spp.). A likely insect vector of this fungus is a bark beetle (*Hylastes* sp.). Feral hogs may also be a vector for leptographium and cause root damage to pine trees. A similar decline condition has been observed in longleaf pines in recent years. Symptoms are similar to those of loblolly decline, but involve a specific vascular stain fungus (*Leptographium serpens*).

Reviews of Ft. Benning RCW cavity tree mortality data and a loblolly decline assessment conducted on Ft. Benning indicate that trees noted as having poor crown vigor tend to die within three years. Additionally, the majority of trees with fair crown health tend to degrade to poor crown health within 10 years. A review of forest inventory data in 2008 revealed that in loblolly pines greater than or equal to 10 inches (in.) diameter at breast height (dbh), 10.3% were classified as having poor crown vigor and 77.4% were fair (Imm et. al. 2008).

Climate is also considered to play a role in pine decline. Droughts have become more frequent in recent years and the Ft. Benning region experienced a period of high temperatures and low precipitation from 1999-2001: three growing seasons. Drought conditions probably exacerbate seasonally limited soil moisture availability to loblolly pine in the well drained to excessively well drained sandy soils of the sandhills, increasing stress. In addition, variability of year-to-year weather patterns has increased. These conditions hinder root growth and could make pines more vulnerable to health problems (ESA and SEMP 2008). While climate change has not been specifically studied at Ft. Benning, Burke et al. (2006) indicated that the frequency of droughts is projected to increase over the southern United States by the 2040s, and increase further by the 2090s. Additionally, temperatures are expected to increase by approximately 4 degrees by 2090 (Burke et al. 2006).

For any pine woodlands on moist or dry sites, regardless of decline, it has been recommended to constrict military training to fewer, permanently altered sites rather than using many sites that are used in rest-recovery rotation; the recovery phase is not likely to be long enough for regeneration of the natural vegetative community (Trame and Harper 1997). Preventative recommendations for pine decline relative to military training, particularly heavy maneuver training, also include restricting activity to as small of an area as feasible and for vehicles to stay as far as possible from the crown edge (recommended 50 ft. from crown edge or drip line) in order to keep vehicles off of tree roots (USACE 2008).

Prescribed burning in loblolly and/or shortleaf pine stands presents a management challenge. Fire is considered to be a disturbance that can contribute to pine decline, particularly when compounded with other impacts such as training. Fire is an integral component of the desired longleaf pine ecosystem, however, and is essential to control regeneration of fire-sensitive hardwoods and off-site pine species, promote the growth of native herbaceous species, and maintain the open forest structure ideal for RCW management.

In addition to decline, there is an ongoing problem with disease and insect damage in off-site pine stands. Slash pine is the only local pine species that does not seem to be affected by the pathogens associated with decline; however, it is highly susceptible to other problems such as fusiform rust and ice damage (USACE 2008). Off-site slash pine stands planted on Ft. Benning are generally more susceptible to insect and disease problems than they would be in their natural habitat, particularly on sites where the topsoil was historically degraded by agriculture and/or timber operations and in areas that receive frequent fire

In 2007, the Ecological Society of America (ESA) and SEMP organized a workshop with more than 40 experts to assess the "state of the science" pertaining to pine decline and to develop short and long-term management recommendations. A technical report prepared by ESA and SEMP (2008) summarizes the workshop, review papers and available literature.

Additionally in 2008, ESA sponsored Dr. Robert Mitchell, Dr. Jeffery Walters, Dr. Craig Hedman and Dr. Rhett Johnson to draft the paper: *Pine Mortality at Ft. Benning: a problem or an opportunity?* The work was initiated to further investigate the potential impacts forest health may have on Ft. Benning's ecosystem and RCW population. Although no research was conducted, nor were any datasets mined or collected for statistical inference, over the course of a three-day site visit, the group generally concluded that understanding the full extent of the pine decline syndrome problem at Ft. Benning could not be known with certainty, and that opportunistic study and research were obviously warranted. The group suggested that a generalized management strategy for silvicultural applications should be implemented once an ordinal assessment (i.e., poor, fair, and good) of declining pine stands was conducted.

The ESA technical report addressed key issues that the Service finds useful relative to defining the pre-project environmental baseline. The authors find that current scientific literature provides meager tools to precisely predict how pine stands will respond to pine decline or how those stands will respond to forest management. During this formal consultation period, the Service and Ft. Benning sought further data to estimate the effects of continuing pine decline under baseline conditions, without the proposed project, on the RCW population and habitat. Two approaches were implemented. The first was a model assessment of future tree growth, decline, and mortality on RCW habitat foraging quality. The second was a modification of the RCW SEPM incorporating data from the previous assessment to simulate RCW group and population dynamics in response to forest decline.

Data on pine size (diameter at breast height (DBH)) and stocking from Ft. Benning stands were used with a tree growth model to simulate future habitat conditions in RCW foraging partitions under five pine decline scenarios (Imm 2008). Tree growth was modeled for a 20-year period using the 2007 Southern Variant of the Forest Vegetation Simulator (FVS) originally developed by staff from the U.S. Forest Service (e.g., Donnelly et al. 2001), with a slight modification to avoid overestimating diameter growth of large trees.

This information deficit prompted Ft. Benning and the Service to modify the RCW SEPM to assess effects of forest decline on RCW habitat and population persistence (see Effects of the Action for detailed information on this model application). To account for the direct effects of pine decline and subsequent health risks that set the stage for the Installation's pre-project environmental baseline, datasets from Ft. Benning's forest inventory database were compiled, and assessed. Scenarios were designed to forecast stand risk based on health conditions. The most likely forecasted effects were later integrated into the RCW demographic model.

In 2008, Imm stated that sustained RCW habitat suitability is critically dependent on sufficient numbers of mature pine trees (10+-inch dbh) as well as the future replacement of those mature trees (Table 8). He points out that short-term suitability of this forest structure (20 years) is solely dependent on a positively-balanced relationship between growth and mortality. The relationship is particularly important on Ft. Benning because current stand structure is at or near minimum basal area thresholds that will diminish the land bases capacity to recover in the near term (Table 8). Note the high mortality rates in the 4-inch diameter class across all pine species types). Additionally, density-independent mortality is governed by interacting factors associated with forest characteristics, such as site conditions, disturbance history, pathogen life cycles, and weather.

To assess the impacts of elevated pine tree mortality on RCW foraging habitat, five scenarios were simulated:

- Simulation 1 - Assumed characteristic tree growth for all trees of all size and health classes. Trees currently classed as having poor crown health are forecasted to die within the first 10 years. For this simulation the remaining trees greater than 14 inch dbh returned to pre-2000 mortality rates, excluding direct losses for Hurricane Andrew (1995), and direct losses associated with southern pine beetle outbreaks (1997, 1998). This simulation represented residual losses associated with the reintroduction of fire.

- Simulation 2 – Assumed characteristic tree growth for all trees of all size and health classes. Trees currently classed as having poor crown health are forecasted to die within the first 10 years. For this simulation a repeated cycle of annual mortality rates observed since 1994 was simulated. These rates impacted trees larger than 14+ inch dbh. A baseline mortality rate of 1% (10 year run) was used for trees smaller than 14 inch dbh. This simulation represents weather, and other extrinsic factors that influence mortality or mortality-related intrinsic factors (e.g. drought and insect outbreaks).

- Simulation 3 - Assumes characteristic tree growth for all trees of all size and health classes. Trees currently classed as having poor crown health are forecasted to die within the first 10 years. For this simulation the remaining trees greater than 14 inch dbh maintained the post-2000 mortality rate. This simulation represents age or size related mortality.

- Simulation 4 –Assumes characteristic tree growth for all trees of all size and health classes. Trees currently classed as having poor crown health are forecasted to die within the first 10 years. For this simulation the remaining trees of all size classes maintain the post- 2000 mortality rates.

- Simulation 5 - Assumes characteristic tree growth for all trees of all size and health classes. Trees currently classed as having poor crown health are forecasted to die within the first 10 years. Based on Menard et al. (2006), all loblolly and shortleaf "fair crown tree vigor class" transition during the first 10 years of simulation then die within the next 10 year simulation. Longleaf mortality rates are those used in simulation 4. Remaining loblolly and shortleaf pine trees are therefore, newly recruited trees and those initially assessed as being good crown vigor class.

The results of this assessment indicate that sustainable RCW foraging habitat will continue to exist for the first three simulations; however, timber management will be limited for simulations

2 and 3 because partition basal area will be at or near the Ft. Benning modified MSS (managed sustainability standard) which is below the MSS. A decline in available foraging habitat will begin to occur within 10 years and become significant within 20 years. Beyond the loss of existing large pine trees, detrimental losses of 8-12-inch trees and elevated losses of longleaf pine would result in persistent problems in meeting RCW foraging habitat requirements.

Because of existing forest ages and observed patterns at Ft. Benning, Imm (2008) suggests that the most plausible simulations are 3, 4, and 5. Simulations 1 and 2 were considered unlikely because the "current forest is aging and stressed, tree mortality is much more likely to increase or stabilize, rather than decline." These results indicate that the pine forest on Ft. Benning will be too young and the number of trees too few to support a recovery level population in the near future.

The modeling began with 303 active clusters, 76 of which were lost to forest decline (based on simulation 3 parameters) in the subsequent 20 years. After 50 additional years, the population regained active clusters and reached 353; still short of the 421 active clusters needed to meet the primary core recovery population goal. Simulation 4 showed that 108 active clusters were lost to forest decline in the first 20 years and the population reached 312 after 50 additional years. The difference in active clusters between the two simulations is due to the increased number of pines that are expected to die under simulation 4 as compared to simulation 3. Simulation 5 was not modeled because the projected loss of all the fair crown tree vigor class of trees was not supported by existing data.

Relict Trillium

Status within the Action Area.

There are five populations of relict trillium being monitored on Ft. Benning. Data from 2005 indicated two populations were increasing and three were stable (USACE 2008). There are other small groups or subpopulations known to exist on Ft. Benning, but no active monitoring is in place for these groups. Construction of MRF 6, a BRAC range, required transplanting three relict trillium plants from the Randall Creek North population to just north of the Baker Creek population on Ft. Benning in the summer of 2008 (USACE 2008).

Monitoring.

The five monitored populations are designated as: Baker Creek (covering approximately 2.34 acres), Kendall Creek North (approximately 11.79 acres), Kendall Creek South (approximately 3.31 acres), Randall Creek North (approximately 27.0 acres), and Randall Creek South (approximately 14.54 acres). Monitoring for these populations is conducted during the peak of flowering, which generally occurs in March and April. Each population contains five, 1-square meter plots. Data collected at each plot include the age class, species and reproductive status of every *Trillium* sp. in the plot; an assessment of canopy cover; and any pertinent habitat condition information such as feral swine (*Sus scrofa*) damage, browsing by animals, signs of flooding, soil erosion or invasive plant species present. These plots are marked by two pieces of 0.5-inch, reinforced bar extending approximately 2.5 ft. above the ground (Ft. Benning 2004b).

On March 2-4, 2009, FBCB personnel and TNC personnel surveyed the Randall Creek North population to quantify the extent of the population that would be directly affected by the proposed road project in that area (PN 65554). Three-leaved plants are considered adults and best show the characteristics of the species, while single-leaved plants are considered juvenile and may remain single-leaved for up to six years (Patrick 2007). Survey results indicate a total of 12,254 three-leaved relict trillium individuals; thousands of single-leaved individuals were observed but not counted. About 94% of the population is on the west side of Randall Creek, and the densest portions are in the middle of the linear-shaped population (Figure 9).

On March 23, 2009, approximately 0.49 acres of the Randall Creek North site was destroyed by personnel taking soil borings in preparation for road construction. Approximately 154 individuals were destroyed (Figure 10).

Threats.

Threats to relict trillium on the Installation include damage from feral swine, soil erosion, training impacts, damage during timber operations, encroachment of invasive plant species such as Japanese honeysuckle and kudzu, and damage from fire. Feral swine have been observed in Compartment K6, where three of the five trillium populations occur. To protect the trillium from swine damage, the Baker Creek, Kendall Creek South and the Kendall Creek North populations have been completely fenced. Feral swine are not currently considered to be a threat at the remaining locations; however, data collected during annual monitoring will indicate if fencing is necessary.

Management and Protection.

To protect plants from human disturbance, the five populations have been designated as sensitive areas and are marked by signs posted along population boundaries. The following additional management measures are in place to protect relict trillium from various types of disturbance (Ft. Benning 2001):

- Fencing populations from feral swine where necessary
- Prohibiting timber harvesting within 200 ft. of the population boundary
- Prohibiting digging and vehicles within the sensitive area signs posted around each population
- Prohibiting prescribed burning within the posted boundaries of each population
- Controlling the feral swine population by trapping or shooting. There is no bag limit on feral swine on the Installation; in fact, hunters can currently present evidence of hogs killed to receive a monetary reward (Ft. Benning 2008c).

Status on Adjacent Lands.

Relict trillium has been found by TNC on two private parcels adjacent to Ft. Benning, one of which is now under a conservation easement with TNC as part of the ACUB program. This large population (over 10,000 stems) is immediately adjacent to the northeast side of the Baker Creek population. Relict trillium has also been found in the greater Ft. Benning area on private lands in Harris County, Georgia; Lee County, Alabama and Tallapoosa County, Alabama (W. Harrison, TNC, pers. comm., 2008).

EFFECTS OF THE ACTION

This section includes an analysis of the direct and indirect effects of the proposed action, including any interrelated or interdependent activities, on the listed species exposed to those effects. The analysis assumes that all conservation measures described as part of the proposed action will be implemented as described in the MCOE BA.

The Service's Consultation Handbook provides guidance on the factors that should be considered for effects analyses.

1. Proximity of the action: to the species, management units, or designated critical habitat units.
2. Distribution: geographic areas where the disturbance occurs
3. Timing: relationship to sensitive periods of a species' life cycle.
4. Nature of the effect: effects of the action on elements of a species' life cycle, population size or variability, or distribution; or on the primary constituent elements of the critical habitat, including direct and indirect effects.
5. Duration: The effects of a proposed action on listed species or critical habitat depend largely on the duration of its effects. Three potential categories of effects are: (1) a short-term event whose effects are relaxed almost immediately (pulse effect), (2) a sustained, long-term, or chronic event whose effects are not relaxed (press effect), or (3) a permanent event that sets a new threshold for some feature of a species' environment (threshold effect). For many species, a proposed action producing a single, short-term effect is less likely to jeopardize the continued existence of a species than a long-term chronic event or the permanent alteration of a species' habitat.
6. Disturbance frequency: the mean number of events per unit of time affects a species differently depending on its recovery rate. If the disturbance frequency is less than the species' recovery rate, the species might persist in the face of the disturbance. If the disturbance frequency equals the species' recovery rate, the species becomes more sensitive to the effects of other disturbances. If the disturbance frequency is greater than a species' recovery rate, the species will be unable to recover between disturbances. Disturbance frequency is an important consideration when evaluating the accumulating effects of proposed actions on listed species and/or designated critical habitat, particularly when it is combined with information on a species' recovery rate.
7. Disturbance intensity: the effect of the disturbance on a population or species as a function of the population or species' state after the disturbance. For example, a disturbance reducing the size of a population or critical habitat unit by 40 percent is more intense than a disturbance reducing population or unit size by 10 percent.
8. Disturbance severity: the effect of a disturbance on a population or species as a function of recovery rate. The longer the recovery rate, the more severe the disturbance. For example, a disturbance from which a species or habitat takes 10 years to recover is more severe than a disturbance requiring two years for recovery. A severe disturbance makes a population or species more susceptible to the effects of multiple actions.

RED-COCKADED WOODPECKER

<u>Factors Considered for Red-cockaded Woodpeckers</u>

Being proximal to the action or geographically located with the disturbance is not an issue in the effects analysis for RCWs. RCWs occur throughout the action area and the disturbances also occur throughout the action area. From a timing perspective, project construction and implementation (i.e., training) will occur at all times of the year, thereby affecting all aspects of RCW life cycle including sensitive periods such as nesting season. Factors related to the nature of the effects, duration and disturbance frequency, intensity and severity are addressed in the following discussion about factors specific to RCWs and throughout the effects analysis.

Loss of RCW cavity trees.

Cavity trees are essential for RCW roosting and nesting; each member of a group has its own cavity. Habitat with limited suitable cavity trees cannot support a growing RCW population (USFWS 2003). As a result of timber clearing and project construction, RCW cavity trees will be removed to construct cantonment projects, roads or ranges. There is potential for cavity tree mortality due to soil erosion and/or compaction from timber operations or construction activities. Additionally, cavity tree mortality after project construction may occur due to impacts from munitions, accidental damage to tree boles from vehicles, soil compaction (root damage) or sedimentation from maneuver training exercises. In this effects analysis, cavity trees were considered lost where impact avoidance and/or adherence to Army RCW Guidelines were deemed infeasible.

Ft. Benning is proposing to count 61 clusters from the A20 impact area towards recovery (Figure 6; actual cluster sites are not yet delineated). However, they only intend to manage 22 (3 on the border, 11 from the DMPRC action, 8 newly-accessible as part of the current consultation). Additionally, Army does not plan to shut down the A20 impact area when a wildfire occurs. Army and Service policy (Service 2003; USDOA 1996) are clear that clusters counted toward recovery must be accessed in order to monitor their status and meet minimum management requirements (e.g., cavity augmentation, midstory removal near cavity tree). In the absence of other information from Range Control and the ability to actually manage all 61 A20 clusters, the Service is considering only 22 clusters as manageable and contributing to recovery.

Controlling wildfire is also an essential part of cavity tree management; a cluster cannot be counted towards recovery if it is not protected. Wildfire in this context is an unintended, incidental consequence of live munitions or other military training. In past consultations, the Service has provided incidental take coverage for random cavity trees that may be burned by military training-caused wildfire in the impact areas. After further consideration, the Service has recognized that this take coverage was inappropriate because the wildfire might cause impacts that were not assessed; for example, there may be group and/or neighborhood impacts depending upon which cavity tree(s) was burned. Currently, the Service believes it is most appropriate to treat wildfire as accidents and address any impacts via emergency consultations, where necessary. In an emergency consultation, the consultation is on the emergency response. The Service and Army would decide on a case-by-case basis the appropriate management response for the particular cluster affected; e.g., placement of an artificial cavity to offset loss of a burned cavity.

Loss of RCW foraging habitat

Detrimental effects on certain RCW groups will be caused by construction clearing of foraging habitat (pine stands over 30 years old) within associated RCW foraging partitions or from mortality related to construction staging areas and/or timber operations. In addition, large clear-cuts (greater than or equal to 25 acres) are known to negatively affect RCW fitness, dispersal and foraging behavior, either through direct habitat loss or habitat fragmentation (Conner and Rudolph 1991, Ferral 1998, Jackson and Parris 1995, Rudolph and Conner 1994, USFWS 2003, and USACE 2008).

Foraging habitat within RCW partitions (pine stands over 30 years old) may be reduced due to live munitions fire and/or maneuver exercises, which could have detrimental effects on the affected RCW groups. In assessing effects, the acreage of foraging habitat that was reasonably certain to be lost over time was subtracted from the affected clusters' foraging habitat totals. Loss, degradation or fragmentation of foraging habitat can result in smaller clutch sizes, reduced fledging success, and reduced group size as habitat becomes insufficient for foraging (Conner and Rudolph 1991).

Noise and harassment

The use of live fire, heavy equipment, increased traffic on infrequently used roads, and an increase in human activity from timber clearing operations and project construction could have an impact on RCW groups in the area (Delaney et al. 2002 and 2004; Hayden et al. 2002; Perkins 2006). This is of particular concern if active RCW cavity trees occur within 200 ft. of the activity, especially during the nesting season. Disturbance around cavity trees can cause RCWs to flush from their cavities and, if the disturbance continues or there is insufficient daylight, to open-roost. This leaves RCWs unprotected from environmental hazards such as inclement weather and predators. Disturbances can also result in increased flushing while incubating eggs and reduced brooding and feeding of nestlings, which can lead to nest failure (Delaney et al. 2004; USFWS 2003, 2006b; J. Walters, NC State University, unpublished report, 2008).

Several research projects have assessed the potential effects of military noise, primarily from large-caliber ranges and artillery simulators, on certain elements of RCW fitness (Jackson and Parris 1995; Doresky et al. 2001; Pater et al. 1999; Delaney et al. 2002; Hayden et al. 2002; J. Walters, NC State University, unpublished report, 2008). Generally, the results of these works have demonstrated that noise events (particularly those historic and relatively constant) from military activities have little to no effect on RCW reproductive success. The majority of these studies, however, used RCW groups that were located on or adjacent to established ranges where RCWs had likely become acclimated to disturbance. The effects of newly introduced noise and associated cumulative disturbances are not well understood; particularly, for large projects or disturbances. Delaney et al. (2004) found that RCWs did not flush from their nests when artillery simulators or 0.50 caliber blank fire were fired greater than 500 ft. away. Although two large caliber ranges are part of the proposed action (MPMG2 and ST2), all cavity trees within 500 ft. of the range edges were within the limits of construction and will be removed. Consequently, indirect impacts associated with large caliber ranges were not assessed in the Army BA.

Recent research provided evidence that military training (e.g., heavy maneuver training or light infantry) and/or civilian activity in the vicinity of RCW clusters may affect RCW behavior by causing more frequent flushing during incubation and/or less frequent feeding of nestlings, which can cause a reduction in nest success or the number of young fledged. In the populations studied, however, such disturbances did not conclusively have a detrimental effect on overall population health or demography (Hayden et. al. 2002; Delaney et al. 2004, 2002; Perkins 2006). In one study, only a very small proportion of the clusters studied (3 of 51) was found to have a high risk of exposure to military training. This sample, however small, revealed lower nesting and fledgling success than clusters studied with less frequent activity. A model used in this study suggested that the population's probability of extinction would increase if a larger proportion of the Installation were subject to high military/civilian activity (Hayden et. al. 2002). Ft. Benning contracted with Dr. Tim Hayden of the Engineer Research and Development Center (ERDC) to conduct similar research evaluating the effects of MCOE activities on the Ft. Benning RCW population.

Harassment of RCWs is expected in areas where adherence to the 1996 Army-wide RCW Guidelines may not be sufficient to prevent adverse impacts to clusters. These guidelines specify the types, duration and frequency of Army training activities that can occur near and within RCW clusters. Training impact studies to date have not shown a negative impact from training on overall population health or stability where training adheres to these guidelines (Hayden et. al. 2002, Perkins 2006, Beaty et. al. 2004). It should be noted, however, that these studies were conducted on Installations with average training loads. Large-scale, intense maneuver training such as that proposed for Ft. Benning was not considered in the development of the Army Guidelines because no such training existed on Installations with RCWs at that time (USACE 2008). Most training courses within the Ft. Benning Maneuver Areas will be repeated between 11 and 23 times a year, with up to 50% of the training conducted at night. This disturbance will be neither historic nor constant. Although RCWs may become acclimated over time, training could initially result in nest failures or cause birds to open-roost (USACE 2008).

Sediment loading

Construction of projects near RCW cavity trees or foraging habitat could cause sediment loading on tree roots, potentially causing tree mortality. Of greater concern is the off-road heavy maneuver training expected with the proposed MCOE actions, which has the potential to cause sediment loading on the roots of RCW cavity trees and trees used for forage trees, or erosion exposing roots, potentially causing tree mortality.

Of the 84,925 acres of heavy maneuver lands that are available for heavy maneuver training, including the Good Hope Maneuver Area and areas under range SDZs, and excluding dudded impact areas and restricted areas, at least 51,035 acres are on highly erodible soils (NRCS GIS data, also used in Ft. Benning 2001). Northeast of Hwy. 27-280, 73,826 acres are available for heavy maneuver, of which 44,074 acres (59.7%) are on highly erodible soils. Approximately 2936 acres (i.e., the southern maneuver area) are expected to suffer 100% habitat degradation over time in the off-road heavy maneuver areas.

Reduction of RCW cluster density
Any of the impacts listed may result in an adverse effect to an RCW group. These effects can, in turn, indirectly affect surrounding RCW groups. The distribution and density of RCW clusters on the landscape is a key factor in the overall stability and health of a RCW population. Reducing cluster density causes populations to be more vulnerable to demographic stochasticity (Crowder et. al. 1998, Walters et. al. 2002b). This potential impact is assessed under the group and neighborhood level analyses.

RCW habitat fragmentation
Habitat contiguity is a key factor in influencing the density and distribution of RCW clusters (Conner and Rudolph 1991, Ferral 1998, Jackson and Parris 1995, Rudolph and Conner 1994, USFWS 2003), which is important at the foraging partition-level and landscape-level of analysis. Areas of unsuitable RCW habitat greater than 200 ft. wide can inhibit an individual group's ability to utilize foraging habitat within its partition and may inhibit the ability of RCWs to disperse from their natal territory to occupy vacant breeding positions in nearby territories. Territory isolation by habitat fragmentation decreases the likelihood of clusters being inhabited by PBGs because dispersing females and subadult, helper males often fail to locate a fragmented or isolated territory with an available breeding position. Isolation is a function of the number, density, and spatial arrangement of active clusters.

Home range follows and radio telemetry work conducted via Virginia Polytechnic Institute have indicated that female RCWs of any age are reluctant to cross openings between 492 and 2,132 ft., and will not cross openings of greater than 2,132 ft. Male RCWs are not as affected by forest gaps (USACE 2008).

Large forest gaps can also cause surrounding stands to become susceptible to wind damage. The potential fragmentation impacts of these and other proposed actions on RCW dispersal are analyzed under the group and neighborhood level analyses as adversely affected by the definition of harm, as well as in the population level analyses.

Edge effect
A related fragmentation issue is a condition termed "edge effect." As more forested lands are cleared, areas that were once forest interior will become the edges of openings. In general, vegetation on the edge of clearings is considerably denser than vegetation in the adjacent forest interior. The increased sunlight and increased probability of disturbed soils cause stand edges to be more susceptible to encroachment from exotic species such as kudzu, Japanese honeysuckle and Chinese privet (*Ligustrum sinense*), as well as aggressive native early-successional plants. Such species typically do not carry fire well, and when burned, the edge is often burned less severely, resulting in limited woody plant mortality. This problem is exacerbated when the edge is a road, building or other urban development where prescribed fire is prohibited. The edge effect poses a problem to RCW management by increasing midstory density in foraging and nesting habitat.

An additional problem associated with forest edges or developed areas is increased cavity competition with kleptoparasites such as southern flying squirrels (*Glaucomys volans*), European starlings (*Sturnus vulgaris*), eastern bluebirds (*Sialia sialis*), red-headed woodpeckers

(*Melanerpes erythrocephalus*) and red-bellied woodpeckers (*Melanerpes carolinus*). Large gaps and forest edges can cause an increase in the number of avian predators (Jackson and Parris 1995) and could lead to increased predation opportunities.

Disturbance and removal of groundcover

In areas with substantial ground disturbance, particularly in the Heavy Maneuver Areas and the Vehicle Recovery Area, there may be too little groundcover by herbaceous plants, plant litter, and pine straw to carry a prescribed ground fire. It is unknown what effect the absence of fire and severely reduced herbaceous plant groundcover will have on arthropod abundance and, in turn, RCW forage availability. Recent evidence indicates frequent fire may increase arboreal arthropods in the diet of RCWs (James et al. 1997; 2001). While hardwood midstory encroachment should not be a problem in heavy traffic areas, it may be in the islands of habitat that remain within the maneuver trail networks, surrounded by habitat with inadequate ground fuels to carry fire prescribed fire from habitat with sufficient fuels. This indirect effect is captured in the cluster level analysis by considering the off-road heavy maneuver areas to be 100% lost over time.

Elimination of existing and planned RCW recruitment sites

Ft. Benning is limited in areas that are currently suitable for additional recruitment sites. Because the locations of recruitment sites are primarily based on habitat conditions, the location of adjacent clusters and the overall population goal of the Installation, all future recruitment sites have not been mapped. However, the RCW ESMP establishes a population goal for each training compartment for the Installation to meet recovery. Therefore, any MCOE projects removing pine habitat, regardless of whether or not the removal is currently within a RCW foraging partition, could restrict or prohibit the associated compartment from supporting the number of clusters designated in the ESMP (Ft. Benning 2002), thereby inhibiting the Installation's ability to meet recovery.

Although foraging habitat losses were not assessed for existing inactive clusters, cavity tree removals and impacts within 200 ft. were assessed in the Cluster and Population Level Analyses. Loss of recruitment sites and inactive clusters may cause Ft. Benning to have fewer than the recommended number of available unoccupied clusters (10% of the number of active clusters) needed to achieve the desired 5% annual population growth for the foreseeable future (USDOA 1996, USFWS 2003).

Potential for delayed population growth and recovery

The Ft. Benning RCW population recovery goal (USFWS 2003) as a primary core population (350 PBGs) was determined by assuming that all suitable upland pine and pine-hardwood habitat was filled with RCW recruitment clusters (i.e., carrying capacity). The estimated future date of attaining 350 PBGs, as part of the recovery objective, for the Ft. Benning population is currently 2023. This is based on a projection of 5 percent annual average population growth (number of PBGs), without habitat limitations. As occupied clusters and vacant recruitment clusters are eliminated or abandoned, either by loss of cavity trees or foraging habitat or isolation, the amount of time necessary to recover RCWs within the Ft. Benning boundary is increased. Included in this effect is the loss of young pine plantations planted for the purpose of RCW recovery. This delay is discussed in the Population Level Analysis.

The Walters et al. (2002) demographic model was used to assess Ft. Benning's ability to meet recovery (351 PBGs) after implementation of the proposed action. Model results will provide an estimate of the timeframe in which recovery could be achieved. Results of this model are discussed later in the Effects Analysis.

The parameters and concepts considered for RCW project analysis are: (1) foraging partition, (2) group, (3) neighborhood, (4) population, and (5) recovery unit. Depending on the results of the previous level, additional analyses may not be necessary.

<u>Cluster Level Analysis - Methodology</u>

Current foraging habitat data was collected for all pine-dominated stands within or partially within each 0.5-mile radius RCW foraging partition that maybe affected by the proposed action. Foraging habitat data were collected between January 3, 2006, and July 29, 2008, for approximately 54,178 acres (approximately 1,978 pine-dominated stands).

Foraging Habitat Partitioning
One half-mile radius foraging habitat partitions were created using the Service's RCW Foraging Habitat Matrix (USFWS 2006a) for every RCW cluster on Ft. Benning, including active, inactive and unmanaged clusters. The Matrix includes an automated GIS tool that spatially divides (partitions) RCW foraging habitat among clusters, and extracts habitat data from associated stand data within each foraging partition. However, the unoccupied habitat allocated to inactive clusters was reallocated to adjacent active clusters for the purposes of the foraging habitat analyses. The partitions created during this step were used to calculate the pre-project foraging habitat totals.

In some areas two or more adjacent clusters were adversely affected by loss of foraging habitat and/or cavity trees. Where there was sufficient combined habitat remaining post-project among affected partitions to support at least one cluster, new partitions were created using either the affected cluster in the best condition (foraging habitat or cavity trees) or shifting one of the cluster centers to optimize the use of the available habitat.

Foraging Habitat Guidelines
Foraging habitat was assessed using the managed stability standard (MSS) and the Recovery Standard (RS) described in the Recovery Plan (USFWS 2003). MSS is typically the threshold used by the Service for assessing the limits of habitat loss; therefore, all projects impacting RCWs must be measured against the MSS criteria (USFWS 2006c). The Service considers adverse project-related losses that reduce RCW habitat below the MSS level as sufficient to cause incidental take. Since Ft. Benning is a RCW primary core recovery population, foraging partitions must also be analyzed using the RS to show that each cluster has the potential to meet the RS in the future. The quantity and quality of foraging habitat required by the RS is greater than the MSS, which is intended to sustain greater RCW group productivity and fitness (USFWS 2003).

The MSS requires (USFWS 2003) a minimum of 3,000 square ft. (ft^2) of pine basal area in stems greater than or equal to 10 inches dbh on at least 75 acres of good quality foraging habitat contiguous to the cluster as defined below (USFWS 2003):

a. Pine stands must be at least 30 years of age or older.
b. Average basal area of pines greater than or equal to 10 inches dbh must be between 40 and 70 ft^2/acre.
c. Average basal area of pines less than 10 inches dbh must be less than 20 ft^2/acre.
d. If a hardwood midstory is present, it must be sparse and less than 7 ft. in height.
e. Total stand basal area, including overstory hardwoods, must be less than 80 ft^2/acre.

Additionally, the Service recommends that all land counted as foraging habitat be within 200 ft. of another foraging stand or the cluster itself and that all land counted as foraging habitat be within 0.25 mile of the cluster (USFWS 2003). Non-foraging habitat is not defined for the MSS in the Recovery Plan; however, the definition in the RS is: 1) any predominately hardwood forest, 2) pine stands less than 30 years old, 3) cleared land such as agricultural lands or recent clearcuts, 4) paved roadways, 5) utility rights-of-way and 6) bodies of water (USFWS 2003).

Service guidance issued by the RCW Recovery Coordinator since the 2003 Recovery Plan has established the following clarification of the total stand basal area requirement:

- Overstory hardwood basal area must be less than or equal to 10 ft^2/acre
- Total stand basal area can exceed 80 ft^2/acre if the maximum limits for overstory hardwood basal area and pines less than 10 inch dbh are not exceeded, and the basal area in pines 10-14 inches dbh is 40-70 ft^2/acre (i.e., the excess in basal area is comprised of pines greater than or equal to 14 inches dbh.).

In addition to low and sparse hardwood midstories being suitable (criteria d. above), sparse-medium and sparse-tall midstories were also considered to be suitable. This modification is acceptable as long as there is data to support stability and breeding success of the resident RCW groups (USACE 2008).

Less than 25% of the active RCW clusters on Ft. Benning have the potential to meet MSS as defined in the Recovery Plan; yet, the Ft. Benning RCW population has continued to grow (FBCB unpub. data, 2008). The average rate of growth over the last 5 years is 2.7%, or 4.5% over the last 12 years (USACE 2008). Because coarse analyses suggested that RCWs on Ft. Benning are able to survive and be reproductively successful in lower quality habitat than that described by the MSS, Ft. Benning and the Service agreed to examine the specific foraging habitat use of the Ft. Benning RCW population.

To determine how the fitness of RCW groups in the project area compared to the available habitat, FBCB personnel analyzed the breeding history of clusters that would be affected by the proposed action relative to the total acreage and basal area of pine stands in each partition, the acres and basal area of suitable habitat using the MSS, and the acres and basal area meeting all MSS criteria except the minimum basal area in pines greater than or equal to 10 inches dbh. None of the results were statistically significant; however, some general trends were noted. Group fitness did not show any obvious trends when compared against the MSS because only approximately 20% of the partitions analyzed met the MSS criteria. Data for the acres and basal area meeting all MSS requirements, except the minimum basal area in pines greater than or equal to 10 in. dbh (30 or 35 ft^2/acre) also did not show a strong trend, other than groups with less than 50 acres of habitat were less productive than those with more habitat. The data for fitness and the total acres of pine-dominated habitat, regardless of MSS suitability, revealed a decreasing trend in breeding success and group size for partitions with less than 50 acres of total pine habitat or greater than or equal to 200 acres of pine habitat. The latter effect is likely related to group density more than foraging habitat, as some clusters on the Installation are somewhat isolated and therefore less likely to contain PBGs.

The 2003 Recovery Plan provides an allowance for individual populations to develop population-specific guidelines that better reflect bird survival in specific areas (USFWS 2003). Additionally, further Service guidance (2005) recognizes that some sites may not currently, or ever, meet the MSS because of catastrophic events, past land use history or ecological reasons. There may be cases where a cluster does not meet the MSS as defined in the Recovery Plan, yet no adverse effect is determined by the Service (USFWS 2005). Proponents who wish to develop population-specific guidelines must demonstrate, through sound science, that multiple generations of RCWs have been stable under the current site conditions. Demographic data must also show that RCW group fitness is not diminished as a result of insufficient habitat and preferably establish a threshold where habitat quantity and/or quality begins to affect group fitness (USACE 2008).

During consultation with the Service (USFWS 2007) a revised MSS was authorized based on 10 years of demographic data provided by FBCB. The revised MSS is a temporary allowance as Ft. Benning continues habitat restoration to convert off-site loblolly pine to a longleaf pine-dominated forest. Using this revised standard, all MSS criteria as listed in the Recovery Plan (USFWS 2003) and above must be met, except that the acceptable basal area range for pines greater than or equal to 10 inches dbh is expanded to include unhealthy stands with an average basal area of greater than or equal to 30 ft^2/acre. The minimum acreage required is directly correlated to the average basal areas of stands within the partition; partitions containing stands with basal area of 40 ft^2/acre would still require a minimum of 75 acres; however, partitions with stands averaging 30 ft^2/acre basal area would require 100 acres to meet the minimum of 3,000 ft^2 total basal area.

While adverse effects are generally not determined until habitat is brought below the MSS, recovery populations have a responsibility to manage toward the RS (USFWS 2003). Because Ft. Benning is a primary core recovery population, foraging habitat impacts were also assessed using the RS, both for current suitability and the ability of each cluster to reach the RS in the future. The RS is commonly referred to as a "desired future condition" of habitat for all increasing RCW populations (USFWS 2005).

The RS requires a minimum of either 120 acres or 200-300 acres of good quality foraging habitat (as defined below) depending on the site indices of soils and dominant pine species within the foraging partition. For systems of high productivity (site index of 60 or more for the dominant pine species), that are in longleaf and are uneven-aged, the RCW Recovery Plan (USFWS 2003) requires that a minimum of 120 acres of good quality foraging habitat be provided for each group of RCWs. For sites with low productivity (site index below 60 for the dominant pine species), 200-300 acres of good quality foraging habitat are required for each RCW group, regardless of species type or stand structure. Ft. Benning staff report that the majority of soils on Ft. Benning have a site index greater than or equal to 60 (USFWS 2003; USDOA 1996), and are, therefore, choosing the 120-acre criteria for their RS analyses. At this time, however, the forest stand structure is not dominated by longleaf pines, and the most common management application is "thinning from below" or even-aged thinning. As a result estimates regarding acres and time needed for recovery are underestimated.

Good quality foraging habitat according to the RS is defined as follows (USFWS 2003):

1. There must be a minimum of 18 pine stems greater than or equal to 14 inches dbh per acre that are greater than or equal to 60 years old. The minimum BA for these pines is 20 ft^2/acre.
2. The basal area for pines from 10-14 inches dbh must be from 0-40 ft^2/acre.
3. The basal area of pines less than 10 inches dbh must be less than 10 ft^2/ acre and less than 20 stems/acre.
4. The minimum combined basal area for categories 1 and 2 above is 40 ft^2/acre.
5. Native herbaceous species must cover at least 40 % or more of the ground.
6. No hardwood midstory exists, or if present, is sparse and less than 7 ft. in height.
7. Canopy hardwoods are absent or less than 10% of the number of canopy trees in longleaf forests and less than 30% of the number of canopy trees in loblolly, shortleaf and other pine forests.
8. All habitat must be within 0.5 mile of the center of the cluster.
9. Foraging habitat must not be separated by more than 200 ft. of non-foraging habitat.

Classification of Habitat

Pine stands that met the revised MSS or RS overstory guidelines and had a sparse hardwood midstory, a moderately dense hardwood midstory that was low in height or a dense hardwood midstory that was low in height were considered "suitable" foraging habitat.

"Potentially suitable habitat" was described as stands that met the minimum requirements, but exceeded maximum limits of pines in certain dbh classes, hardwood midstory density or height and overstory hardwood density. These stands have the necessary pine basal area and would meet the revised MSS or RS with midstory removal, prescribed burning and/or thinning. Stands with suitable overstory characteristics containing a moderately dense or dense midstory that was moderate or tall in height were in this potentially suitable category. All pine-dominated stands that did not fall into the suitable or potentially suitable pine categories were classified as "future potential habitat." These stands will require time for pine to grow and mature to a sufficient size and age to meet the revised MSS or RS pine density, size (dbh) and/or age requirements.

Stands within the A20 Dudded Impact Area were not accessible by ground access and were delineated by FBLMB using aerial observations and photography. The age of these stands was approximated by FBLMB using historical stand data; however, no pine stem or basal area data was available. Since this habitat makes up a considerable portion of partitions within and adjacent to the A20 Dudded Impact Area this habitat was included in foraging analyses as "forested acres."

Areas that will not be suitable habitat for many years, if ever, and stands that are not managed by FBLMB were classified as "unsuitable" habitat. This designation included hardwood drainages that would not typically support a pine-dominated overstory regardless of management, cleared areas that have not been replanted in pines, upland hardwood stands that are not planned for conversion to pine, paved areas, open water and impact areas or other inaccessible stands.

As stated above, the MSS requires that habitat cannot be separated by greater than 200ft. of non-foraging habitat, defined in the Recovery Plan as: 1) any predominately hardwood forest, 2) pine stands less than 30 years old, 3) cleared land such as agricultural lands or recent clearcuts, 4) paved roadways, 5) utility rights-of-way and 6) bodies of water. The RCW Matrix software application, however, classifies stands as "noncontiguous" if they are separated by any stand that is not classified as current "suitable" foraging habitat (USFWS 2006a). Due to the poor habitat conditions on much of the Installation, approximately 21% of active RCW clusters have stands of suitable habitat that are separated by stands of future potential habitat. In 15% of the active clusters, the cavity trees are located in habitat designated as future potential habitat. For Army's analysis, future potential habitat not meeting the "non-foraging habitat" criteria listed above was allowed to connect suitable habitat even though it might be substandard at this time.

While pine stands less than 30 years old cannot connect suitable habitat today, these stands will contribute to habitat totals and contiguity at recovery. In determining clusters' ability to meet recovery in the future, pine stands less than 30 years old were treated the same as any pine habitat in their ability to serve as links between other pine stands.

Other than age, the only minimum criteria for stand suitability (listed above) in the MSS is the basal area in pines greater than or equal to 10 inches dbh; all other criteria are maximum values that could be improved with management. Therefore, in most cases, if a stand meets the basal area in pines greater than or equal to 10 inches dbh criteria, it will be classified as either "suitable" or "potentially suitable" habitat. Of 254 occupied foraging partitions analyzed, 62 (24.4%) had greater than or equal to 75 acres of stands with a minimum of 40 ft^2/acre in pines greater than or equal to10 inches dbh and could potentially meet the MSS. Of these, 18 partitions (7.0%) had greater than or equal to120 acres and 44 (17.3%) had 75-119 acres. Twenty-three clusters (9.1%) contained 0 acres of stands with greater than or equal to 40 ft^2 basal area/acre. The majority (168 clusters) (66%) of the partitions contained less than 75 acres with greater than or equal to 40 ft^2 /acre in pines greater than or equal to 10 inches dbh (USACE 2007b).

Conversely, 163 (64%) clusters had greater than or equal to 75 acres of stands with a minimum of 30 ft^2/acre, of which 84 clusters (33.0%) had greater than or equal to 120 acres and 79 clusters (31.1%) had 75-119 acres. Eighty-eight clusters (34.6%) had less than 75 acres of habitat, and three clusters (1.2%) contained no stands with a minimum basal area of 30 $ft.^2$/acre.

Group Level Analysis – Methodology

Retaining sufficient foraging habitat alone does not ensure the persistence of an RCW group. The continued occupation of a cluster not only depends on the amount of foraging habitat, but also depends on the density of active clusters around it (Hooper and Lennartz 1995). Research has shown that the more aggregated RCW clusters are, the higher the probability of persistence, even with substantial foraging habitat loss (Crowder et al. 1998, Letcher et al. 1998). RCW groups in moderately dense to dense populations have been shown to be less sensitive (i.e., group size and productivity) to drastic loss in habitat than in sparser populations with seemingly more available foraging habitat (Hooper and Lennartz 1995). Therefore, when active RCW clusters are deemed adversely affected for a project, it is necessary to assess the impact of that loss on the demographic stability of neighboring RCW groups. This is done by examining the density of active RCW clusters on the landscape.

For the group density analyses in this document, clusters having greater than or equal to 4.7 active clusters within 1.25 miles were considered healthy and were given a "dense" designation. Clusters with 2.6 to 4.6 active clusters within 1.25 miles were considered to have "moderate" density. Clusters with less than or equal to 2.5 active clusters within 1.25 miles were considered "sparse," and therefore more vulnerable to abandonment because of lack of emigration/immigration (Conner and Rudolph 1991).

A 1.25-mile-radius buffer was drawn around the cluster center for every active cluster within 0.5 mile of a project's construction limits, adjacent to a cluster adversely affected (direct or indirect) or affected by MCOE projects (some foraging habitat or cavity trees removed). For each cluster analyzed, the number of active clusters within 1.25 miles of its cluster center was calculated. All clusters with a cluster area (minimum convex polygon of all cavity trees and a 200 ft. buffer around them) within 1.25 miles of the target cluster's center were included in the cluster density totals. These totals did not include the subject cluster if it was expected to be adversely affected by a MCOE project. However, affected clusters were included in the pre-project density totals of their neighboring clusters.

Clusters with greater than or equal to 4.7 active groups within 1.25 miles post-project were considered to be unaffected by the associated project or suite of projects. Clusters whose densities were reduced from "dense" or "moderate" to "sparse" were considered to be adversely affected and therefore vulnerable to abandonment as a result of the proposed project(s). Clusters that were "sparse" pre-MCOE were generally considered to be adversely effected, particularly if project-related habitat removals caused the subject cluster to become more isolated and thus more vulnerable to abandonment.

Eight RCW clusters adjacent to the DMPRC in 2004 were expected to become abandoned (Ft. Benning 2005, USFWS 2006c). Although no clusters have been abandoned yet as a result of the timber clearing and construction of the ranges, these clusters were not included in group density and neighborhood-level analyses (USACE 2008). The A20 and K15 Impact Area clusters were also not included in group density calculations since they are covered under the ITS of a previous biological opinion (USFWS 2002).

Neighborhood Level Analysis - Methodology

Guidance set forth by the Service (USFWS and NMFS 1998) states that "when determining an action area, it must include the project site and all the areas surrounding the activity up to where the effects will no longer be felt by the listed species." The intent of the neighborhood analysis is to account for the potential negative impacts of a project on RCW demography through habitat loss or fragmentation at the neighborhood level.

A 2.57-mile buffer was drawn around every active RCW cluster impacted by BRAC projects (USACE 2007). This distance is the average successful dispersal distance based on 11 years of demographic monitoring by the FBCB (USACE 2008). The neighborhood analysis first looked at the density of RCW groups within a 1.25-mile radius of clusters that were not directly affected by projects, but were adjacent to clusters that were impacted. If the post-project analysis showed less than 2.5 groups within a 1.25-mile radius of the subject cluster, it was considered adversely affected.

Population Level Analysis - Methodology

Service guidance (USFWS 2006c), requires all projects be analyzed at the population level, regardless of whether or not there are adverse effects at the partition level. In this case, the population level analysis considers the ability of Ft. Benning to meet its RCW population goal (351 potential breeding pairs (PBGs), 421 total managed clusters) post-MCOE.

After subtracting all partitions expected to be adversely affected at the partition level, group and neighborhood levels, the remaining clusters were analyzed for fragmentation and reduction of productivity and dispersal. The fragmentation and reduction of productivity and dispersal analyses were more subjective because there are no set criteria.

To determine the amount of contiguous acreage pre- and post-MCOE, stands that were isolated from any other pine-dominated stands by greater than 200 ft. were excluded from the acreage totals. The only exception was if an assemblage of stands was separated by greater than 200 ft., but together contained sufficient habitat to support at least one cluster (150 acres).

Effects Analysis - Results

Cluster Level Analysis

The total number of clusters lost due to removal of foraging habitat, cavity trees, and harassment is 60. A description of each cluster assessment can be found in the MCOE BA and addendums (USACE 2008, 2009). The cluster level assessment includes a narrative on the proposed action; the projected effects of the proposed action; and the analysis that supports the determination of the projected effects.

Group Level Analysis – Results

The group level analysis evaluates density effects to clusters directly impacted by the proposed MCOE projects, but not lost at the cluster level. Seven clusters (L02-02R, O07-01R, O07-03R, O09-02, O12-02, R01-01 and SHC-02) were considered lost due to project related group density reduction around the subject clusters (i.e., less than 4.7 groups within 1.25 miles of the adversely effected cluster).

Neighborhood Level Analysis - Results

The neighborhood level analysis evaluates indirect group density impacts to clusters not directly impacted by MCOE projects, but within a 2.57 mile radius "Neighborhood" (see Section 5.5 of the MCOE Biological Assessment (USACE 2008)). Six clusters (D11-03R, J01-01, J01-03R, O04-02, O06-03R, and O06-04R) were considered adversely affected due to project-related neighborhood level impacts.

Population Level Analysis - Results
Based on the Service's impact analysis guidance (USFWS 2005), 73 of the 120 analyzed active RCW clusters (61%) are likely to be lost by the proposed action. Of the 120 clusters analyzed for impacts, 102 were active and 98 of those active clusters (96%) were inhabited by PBGs in 2008. The proposed action is expected to reduce the number of PBGs from 258 to 188 due to direct effects. Long-term training will affect another 24 PBGs which reduces the total to 164.

Dudded Impact Area Clusters. RCW clusters in the forested, dudded impact areas which are not accessible for management cannot be counted toward the Installation recovery goal (USDOA 1996, 2007). However, it is generally recognized that such areas, particularly the A20 and K15 impact areas, are populated by RCW groups and provide important foraging and dispersal habitat, as well as being a source of juvenile RCWs as future breeders in territories outside the impact area. Therefore, introduced or increased impacts to habitat in these areas could directly and indirectly impact the overall health and stability of the Ft. Benning RCW population. The proposed MPMG2 range would result in the loss of cavity trees and foraging habitat for four unmanaged clusters and approximately 318 acres of foraging habitat in A20.

Habitat Loss and Fragmentation. Research has shown that the more aggregated RCW clusters are, the higher the probability of persistence, even with considerable foraging habitat loss (Hooper and Lennartz 1995; Walters et al. 2002b). Therefore, the area with the greatest aggregation of clusters would be considered to be the most stable. Pre-project, these areas on Ft. Benning are in and around the A20 Impact Area in the southwest, northeast of Ochillee Creek around Hourglass Road in the center of the Installation and in the Oscar compartments in the northwestern corner of the Installation. Under the proposed action, there will be substantial reductions in cluster density around the Oscar Small Arms Complex, around the A20 Impact Area, in the Northern Maneuver Area and in the Southern Maneuver Area.

Home range follows and radio telemetry studies have indicated that female RCWs of any age are reluctant to cross openings 492 - 2,132 ft. (0.11 mi.), and will not cross openings of greater than 2,132 ft. (0.40 mi.) (J. Walters, VA Polytechnic Institute, pers. comm. 2007). The proposed action will create several large openings, the largest being the MPMG2 range (788 acres (including 318 acres in the A20 Impact Area and 469 acres in A17), averaging 1.23 by 1.56 mi.), ST2 (562.63 acres, averaging 1.97 by 1.38 mi.), and the Southern Maneuver Area (3,035.86 acres, 4.39 by 1.47 mi.). While these openings will be substantial and RCWs (females in particular) are unlikely to cross them directly on a regular basis, sufficient dispersal corridors may remain so that adjoining habitats will not be permanently isolated as a result of the proposed action. Walters et al. (2002) demographic model was used to assess habitat contiguity for post-MCOE conditions. Recent aerial survey of the K15 impact area indicates a dispersal corridor is expected to remain to provide connectivity between groups in the northeast and south of the K15.

Population Recovery and Habitat Restoration. With impacted inactive clusters taken out and including clusters that are currently included in an ITS but have greater than 120 acres of pine habitat, 83 partitions (+4 inactive) will contain less than 120 acres of pine habitat, 50 (0 inactive) will contain 120-150 acres of habitat, and 135 (+11 inactive) partitions will contain greater than or equal to 150 acres of pine habitat post-project. At a minimum, there will be 146 clusters post-MCOE that will have greater than or equal to 150 acres of contiguous, managed pine habitat (34.7% of the approximately 421 clusters needed for recovery).

Post-MCOE, 77,979 acres are potentially contiguous pine habitat that can be managed for RCWs (including 71,115 acres outside of the A20 Impact Area and 6,864 acres within the A20). This total includes all available pine habitat, regardless of its current condition. Of the 77,979 acres of contiguous, managed pine remaining post-project, 14,224 acres are under 30 years old. Of the acreage less than 30 years old, 11,441 acres are longleaf-dominated. Approximately 3,903 acres of habitat and 16 clusters in the northeastern corner of the Installation may be vulnerable to isolation due to lack of contiguous habitat between the corner and the remainder of the Ft. Benning RCW (Figure 12). Aerial surveys conducted in April 2009 confirmed a sufficient dispersal corridor between the Hasting range and the DMPRC to link the northeastern RCW clusters to the nearest active clusters located south of the Kilo impact area (see Figure 2, area labeled "K2). Therefore, the probability of isolation is decreased and those acres and clusters continue to be counted towards Ft. Benning's recovery objective.

When trees with poor crown vigor are included, approximately 31,562 acres (40.5% of 77,979 acres) are currently suitable or potentially suitable RCW habitat (greater than or equal to 30 yrs and greater than or equal to 30 sq. ft. of basal area). Not including the trees with poor crown vigor, 25,419 acres (32.6% of 77,979) are potentially suitable or suitable RCW habitat. (Note: tree health data are not available for all stands).

Based on average percentages of clusters inhabited by PBGs or solitary males and those clusters that are captured by a neighboring RCW group or inactive, Ft. Benning currently needs to manage 421 clusters to have 351 PBGs and reach its recovery goal. However, the total number of clusters needed may increase if part of the RCW population becomes permanently isolated due to habitat fragmentation and/or there is a decrease in the proportion of clusters inhabited by PBGs.

At recovery, partitions are expected to contain a minimum of 120 acres of good quality foraging habitat meeting all of the recovery standard criteria (USFWS 2003). While it may be possible for 100% of the habitat within some partitions to meet the recovery standard (thereby requiring only 120 total acres of pine habitat), it is more likely that, even using single-tree selection and uneven-aged management, some percentage of the pine stands in each partition will be in various stages of succession; in poor health; damaged from fire, weather, or training; or will need to be cleared for projects or military training. It is more probable that the extensive loss of habitat resulting from project proposals and the declining pine habitat will result in the need for much larger habitat requirements and will lead to significant reductions in group size and reproduction (DeLotelle et al. 1987, Beever and Dryden 1992, Hardesty et al. 1997).

Therefore, to help ensure sufficient habitat for 421 clusters, 150 acres per partition was used to allow a buffer for future project removals or loss of stands due to disease or wildfire. This decision was supported by the definitive foraging habitat and fitness study for Sandhills RCWs (conducted in North Carolina), which found that the average home range size in the best quality habitat was nearly 200 acres (Walters et al. 2002). The 120-acre foraging habitat minimum acreage in the RS (USFWS 2003) is based on contiguous suitable habitat growing on high quality sites. These conditions do not currently exist on Ft. Benning. RCW home range follows conducted between December 2004 and January 2009 during the non-breeding season indicate home ranges (using fixed kernel density estimator) for 10 clusters ranged between 90 and 257 acres, with a mean home range of 162 acres. Home range under sampling was a result of eventual cluster abandonment after timber harvesting and initial construction of the DMPRC in 2004. Home range data are continuously being analyzed because data collection during the non-breeding season is continuous (J. Neufeldt, pers.comm., Army, 2009)

Using the allocation of 150 acres/cluster, Ft. Benning will need 63,150 acres of contiguous longleaf habitat for recovery. The pine habitat remaining post-project (77,979 acres) could potentially support 520 clusters at 150 acres/cluster, or 481 clusters at 162 acres/cluster, which could be sufficient to meet recovery in the future depending on the spatial configuration of the remaining habitat and the distribution of RCWs on the landscape (but not considering habitat and population losses attributed to pine decline, future project removals/impacts or losses due to training impacts). As project designs are refined, the number of pine acres available to grow RCWs could increase, which would give the Army some flexibility in RCW management (e.g., location of recruitment clusters) and location of new or modified construction and/or training.

Beneficial Effects of Conservation Activities. Ft. Benning has committed to implementing many activities that contribute to conservation of RCWs (see the "Ongoing and Future Conservation Activities" section earlier in this document). Continuing to manage groups that have been included in ITSs from previous BOs directly benefits those groups and enables them to continue to contribute to population persistence. For those groups, however, it is important to RCW conservation that the birds and their habitat are considered. The species cannot recover if habitat is managed for the MSS rather than the RS. In order for adversely affected groups to be counted towards recovery, sustainable bird productivity and behavior must be observed, but some configuration of habitat (e.g., suitable, potentially suitable, future potentially suitable) must be present to indicate the RS can be met.

The environmental awareness training program benefits the Ft. Benning RCW population by highlighting listed species and other natural resources as valuable and in need of protection. Initiating an effort to manage ACUB and other habitat contiguous to Ft. Benning can augment the existing RCW population once the habitat is grown and managed to the appropriate standards (e.g., size and age of trees, amount of basal area, etc). Managing lands to create or improve RCW habitat that is not contiguous or sufficiently close to Ft. Benning to establish a demographically connected, single population will not enhance the Ft. Benning population, although long-term benefits to RCW conservation in the SHRU and region can potentially accrue. SEPMs or other analyses demonstrating the demographic function of such properties have not been conducted.

Full implementation of the habitat conservation plan described in the biological assessment, to the extent that contiguous RCW habitat is created or improved can provide Ft. Benning with additional flexibility in how and where training and construction actions are placed on the Installation. Once the additional acreage is restored and grown to provide suitable habitat for

RCWs, it can be used to reach or exceed Ft. Benning's recovery goal. Populations should be recovered as rapidly as possible, because loss of genetic variation and the adverse risks of inbreeding depression increases with the length of time that populations remain small or populations remain fragmented. Smaller populations are less able to persist.

Survival/Population Viability. Post-project, there will be approximately 180 clusters inhabited by PBGs (based on 2008 nesting data) (USACE 2009). Of the four main threats to population viability, this number is considered to be large enough to withstand threats of demographic stochasticity (i.e., randomly occurring events affecting individuals) and inbreeding depression. The Ft. Benning population will be more vulnerable in its ability to endure the potential effects from environmental stochasticity (i.e., random changes in environmental conditions and their effects on populations such as drought or insect). Our best estimate of the population size necessary to withstand effects of environmental stochasticity is greater than or equal to 250 PBG's. However, this is a minimum estimate based on model simulations, and it may contain some error (USFWS 2003; USDOA 2007). Retaining genetic variability despite genetic drift could require 350-1000 or more PBGs in a population (USFWS 2003). This risk can be alleviated by the introduction (via translocation or natural dispersal) of 1-10 migrants per generation (0.25 to 2.5 migrants per year). A second practical way to reduce the effects of genetic drift is to recover the species as quickly as possible.

Inbreeding depression is expected to affect population viability in populations of less than 40 potential breeding groups, and may be a significant factor affecting viability in isolated populations of 40 to 100 potential breeding groups as well. Immigration rates of two or more migrants per year can effectively reduce inbreeding in populations of any size, including very small ones. Effects of demographic stochasticity on population viability vary with the spatial arrangement of groups. Populations as small as 25 potential breeding groups can be surprisingly resistant to random demographic events, if those groups are highly aggregated in space. Populations as large as 100 potential breeding groups can be impacted by demographic stochasticity, if groups are not aggregated and dispersal of helpers is disrupted. Demographic stochasticity is not expected to affect populations larger than 100 potential breeding groups. Similarly, effects of environmental stochasticity vary with the spatial arrangement of groups.

Catastrophes are rare, irregularly occurring events that produce extreme changes in demography and population dynamics. Hurricanes are the greatest catastrophic threat to population viability. The primary element in addressing the hurricane threat is to reduce risk to the species by maintaining a number of populations that are broadly spaced geographically, and including as many inland populations as possible among them. As an inland population, the post-project vulnerability of the Ft. Benning population adds even more risk to the recovery unit and species.

Modeling Efforts to Assess Response of RCW Population to Habitat Loss and Training

The Army and Service used two tools to assess whether or not the losses at Ft. Benning appreciably reduce the likelihood of the survival and recovery of the Ft. Benning population: 1) a population viability analysis model developed by Dr. Timothy Hayden of the Engineer Research Development Center and 2) a population dynamics model developed by Dr. Jeffery Walters et al. of Virginia Polytechnic Institute.

Population Viability Analysis and Training Effects (Hayden and Melton 2008)
As expected, the RCW population, like all threatened and endangered species is vulnerable to non-compatible land-use. High impact effects decrease reproductive success as well as survivorship of adults and offspring, thereby reducing the recovery rate and increasing population vulnerability.

In this assessment, six scenarios were evaluated by Dr. Hayden using different impact levels to assess RCW population vulnerability and recovery likelihood. For this model, population vulnerability, and the ability to meet recovery goals, is dependent upon the distance and magnitude that mounted maneuver training impacts radiate into the adjacent forest; e.g., 200 ft, 1/8 mile, ¼ mile and ½ mile. Currently, these magnitude and distance-dependent thresholds are unclear. Therefore, key parameters needed to be established in order to make probabilistic projections. The parameters included:

1) Installation biologists categorizing RCW clusters that were determined to be subject to high or low levels of training activity, and establishing estimates of hypothetical impacts of MCOE actions on RCW fecundity and survival. These impacts were normalized by Installation biologists categorizing clusters that are already on the Installation and that they believed were subject to high or low levels of training activities. In the absence of observed data, this process was an exercise in subjective reasoning based on their knowledge of the Installation;

2) Estimates of adult and juvenile survival and fecundity were then estimated in order to normalize estimates between clusters classified as having historically high levels of training versus the rest of the population. Slight differences were noted and used to weight survival parameters for the proportion of clusters projected to be subject to high impacts; and

3) Setting the training level parameters based on past history, biologists determined that the MCOE impacts would likely be more detrimental than the historical effects on fecundity. Because there are no empirical data for effects of MCOE-type activities on RCW fecundity, it was agreed to reduce the baseline levels of fecundity by 37.9% which reduced the value from 2.1255 to 1.3191. This number was in line with data observed during the empirical study conducted at Ft. Stewart from 1997 to 1999.

The population viability analysis (PVA) produced five categories for population statistics. The categories are:

1) the rate of population increase--represented as lambda or the potential per capita rate of increase implied by the input parameters relating to survival and reproduction, in the absence of density-dependent population regulation; e.g., catastrophes, and in the absence of immigration or losses through death. Values of lambda less than one indicate average survival of fecundity rates insufficient to avoid certain eventual extinction. Values greater than one indicate favorable survival rates but do not necessarily imply assured population persistence because of the presence of population ceilings and the potential to be combined with various stochastic events.

2) pseudoextinction probability--the probability that the population will fall below five breeding females within the designation time period; i.e., 10, 20 and 100 years.

3) extinction risk classification--uses extinction risk criteria relating to quantitative population viability analysis to define the risk of extinction as "vulnerable" when there is a greater than 10% probability that pseudoextinction would occur within 100 years, "endangered" when there is a greater than 20% probability that pseudoextinction would occur within 20 years, and "critical" when there is a greater than 50% probability that pseudoextinction would occur within 10 years.

4) probability of achieving the target population--the probability of reaching greater than 351 PBG's at year 10, 20 and 100.

5) the prognosis classification--the prospects for observing a breeding female population equal to or exceeding the target population value at the end of the designated time period; "optimistic" is the probability of achieving the target population is greater than 90%, "better than even" is the probability of achieving the target population is greater than 50%, and "pessimistic" which is the probability of achieving the target population is less than 10%.

The model results are best evaluated as the relative change in risk across scenarios and/or time periods. There is no empirical data available for the training activities with MCOE and effects on RCWs. The rate of population increase (lambda) was estimated at less than 1.0 across all scenarios. At the 200-foot disturbance distance, the buffer distance for disturbance that is used in the Army-wide Guidelines, lambda was recorded at 0.93 with MCOE and 0.98 without MCOE. The pseudoextinction probability revealed no effect for the 10 and 20 year projections, but for the 100 year run, at the 200 foot distance, the extinction probability increased from 0.32 to 0.99 with MCOE.

Under all scenarios, the estimated probability of being classified as vulnerable is greater than 58%; baseline being 58% probability and the 200-ft distance scenario 90%. Vulnerable is defined as the probability of pseudoextinction within 100 years is greater than or equal to 0.1 (10%). The probability of achieving the target population at 100 years was reported as pessimistic for all scenarios. Pessimistic is defined as the probability of achieving the target population is less than 0.1 (10%). The low probability of achieving the target population across all scenarios is a function of the rate of increase being less than one. For the baseline scenario, the probability is 66% and for the 200-ft. scenario 93%. As a result, the probability of the target prognosis of pessimistic is more likely than optimistic for all scenarios. Based on the information developed by the Army to capture RCW clusters that would be subjected to training effects, an additional 24 groups will be adversely affected by the high degree of training impacts projected to occur within 200 feet of these group's cavity trees. These clusters are not expected to incur habitat impacts.

RCW Demographic Modeling
Spatially-explicit demographic models can be used to detect lagging impacts of land-use change within specific areas on population expansion across a landscape as well as reflect existing conditions of habitat and population occupancy. To simulate RCW population response to planned MCOE actions, the post-BRAC/pre-MCOE landscape was used to define the Installation's pre-project (MCOE) baseline. This model also included existing RCW cluster locations with the following fundamental assumptions.

1) All pine stands 60 years and older are considered suitable foraging habitat and structured in longleaf pine,
2) Habitat quality does not deteriorate,
3) All new groups only require 120 acres of pine for foraging. The model only provides two options for foraging habitat; 120 acres or 200 acres.
4) Existing groups remain regardless of current habitat conditions

Key parameters include:

- Population growth occurs through budding and occupations of recruitment clusters, and does not consider translocation or pioneering.
- Bird movement to unoccupied areas and establishment of new groups is based on observation data.
- The model evaluates only direct impacts of MCOE-related landscape change
- The model simulations were run with and without certain groups in the A20 impact area, with and without MCOE actions, and with and without certain ACUB properties.
- The simulations extend 50 years, with greatest accuracy occurring within the first 20 years (a total of 70-year modeling timeframe).

Initial results (i.e., unmodified) projected that the Ft. Benning RCW population would continue to increase at a reduced rate under the pre-MCOE condition. However, the removal of groups resulting from the MCOE action would reduce the total population significantly. The MCOE projection indicated that nearly 50 years would be needed for the population to get back to its current level, and several local areas will have unstable population attributes. The MCOE model projection also indicated that the RCW population would not be capable of attaining recovery within 50 years. Without MCOE actions (baseline only), the population was forecasted to exceed the recovery target within 50 years.

Results of the combined models

The combined models are RCW SEPMs with forest decline scenarios and simulations. Forest decline simulations 3 and 4 were considered the most likely and reasonable to occur. Results of these models and simulations, including effects of MCOE with 25 RCW clusters in the A20 impact area and ACUB lands (3,200 or 80,000 acres), indicate that a RCW population at the recovery size objective of 421 active clusters cannot be attained during the 70-year model and simulation time period. Without forest decline and MCOE, the Ft. Benning population was forecast to reach its recovery size objective (421 active clusters) by the year 2023. Effects of forest decline (S4) without MCOE prolongs the future date for the population to reach the recovery size objective by 68 years, until 2091. With the added effects of MCOE, the Ft. Benning primary core recovery population does not attain 421 active clusters until 2139 (Table 10, 50 Post A20=25 ACUB S4). This exceeds by 54 years the projected year (2085) at which all RCW recovery populations and units currently are forecast to attain their size objectives (Table 9).

The Addendum RCW spatially explicit individual-based population models (SEPMs) provide an opportunity to assess effects of various scenarios, given the assumptions of the model, its structure, and the data input. Our interests in RCW SEPMs included a comparison of the estimated future Benning RCW population under baseline conditions with pine decline relative to the proposed MCOE project with pine decline (Table 10). Underlying issues concerned the extent the Installation would retain sufficient habitat to support a primary core recovery population of 421 clusters (350 PBGs), the future time of attaining such a population as affected by different project and pine decline scenarios, and how changes in project design altered these and other outcomes.

The Addendum (Table 4-24, p. 242 included in Appendix B, USACE 2008) reports results of 19 various scenarios. These do not include all of those for which the Service originally was most interested. Simulation output data also was provided to the Service for 27 simulations, eight of which were not reported in the Addendum (Table 10). From either source of data, however, the total number of RCW partitions on Ft. Benning was not reported, whether occupied by RCWs or not. Reported data are insufficient to assess the extent the Installation may or may not support 421 clusters under various scenarios.

The following summaries assume sufficient habitat is available to support 421 clusters in each simulation. The models do not simulate indirect disturbance effects of harassment by heavy maneuver training on reduced RCW fitness and/or RCW fidelity to clusters. Also, it is assumed the initial number of clusters input for year 1 of each scenario is correct, and has not been subsequently modified by adjustments to the project construction footprint or other changes described in the Addendum. The initial number of clusters for year 1 during the 20-year pine decline simulations was not reported in the Addendum or in the spreadsheet data. Initial groups were only reported (Addendum, Table 4-24) for year 1 of the 50-year simulations following the 20-year pine decline simulations (Table 10).

Given these assumptions, the purpose of the following assessment is to compare the population size (active clusters), years and delays associated with various simulations in attaining a recovery population of 421 clusters. Delays are caused by MCOE projects that reduce the number of RCW groups by incidental take through habitat loss. Lost groups, assuming sufficient habitat remains available, are replaced later by inducement at recruitment clusters in restored habitat at other sites on the installation, or by budding. In general, the greater the number of groups lost by MCOE, the smaller the subsequent population and the greater the delay.

The total simulated period for each scenario was 70 years and each scenario was replicated 70 times. The model for each scenario was simulated in a 20-year period, followed by a 50-year period, for the total 70-year period. Pine decline occurred during the 20-year period. It was assumed that Ft. Benning planted or reforested all declined stands with longleaf, representing a restoration phase, in which the forest continued to grow and age during the subsequent 50-year simulation period.

Limitations in model programming and structure did not allow a sufficient simulation period (years) for the RCW population to grow, following the adverse effects of pine decline and/or MCOE, in response to habitat restoration and recruitment clusters to a time when the recovery population size objective of 421 active clusters was attained. To estimate this future time, we made a deterministic forecast for each scenario based on the mean number of simulated clusters at year 70 (2079), with a future average annual 2.5 percent geometric growth (rate = 0.025). The geometric growth rate, r, is:

$$r = \sqrt[t]{Pf / Pi} - 1 \text{ , or } \log(1 + r) = \frac{\log(Pf / Pi)}{t}$$

where *Pf* is the final RCW population size, *Pi* is the initial population size, and *t* is the number of years of growth. Given *r*, the time (years) required to reach a final population size *Pf* of 421 active clusters from an initial population, *Pi*, is:

$$t = \frac{\log(Pf / Pi)}{\log(1 + r)}$$

The observed average annual percent growth (active clusters) of the Ft. Benning population during the last 5 growth interval years was 2.7 percent ($r = 0.027$). As a deterministic forecast, the estimates do not incorporate spatial population dynamics or stochastic demographic and environmental variation of the SEPMs.

Ft. Benning provided the raw simulation output data for selected variables of the replicates for each model scenario. With these data, we identified the minimum and maximum number of active clusters at the end of the 70-year simulation period for each scenario. Given the data on the frequency distribution of number of active clusters for each scenario, we calculated from a normal probability distribution the number of active clusters for which there was a 0.90 probability that all other values for active clusters generated by the scenario simulation would be equal or greater. This represented a worst case scenario, conversely, where there was a 0.10 probability the number of active clusters would be equal to or less than this value. Since the probability distribution was not strictly normal for all frequency distributions, we also identified the actual value from the simulation data for which 90 percent of all the active cluster values was equal or greater at the end of the 70-year simulation. Likewise, we considered this as an unfavorable scenario, where 10 percent of the replicate simulations for each scenario generated an equal of lower value for the number of active clusters. Values for the 0.90 probability and 90 percent threshold were similar (Table 11).

The active clusters by these unfavorable outcomes at the end of the 70-year simulation period were less than the mean number and less than the 421 active clusters for the Ft. Benning primary core population recovery size objective. Using the average annual 2.5 percent geometric growth rate, described above, we forecast the future year of attaining the recovery population size objective of 421 active clusters.

As reported in the Addendum and from simulation spreadsheet data, all base simulations with recruitment clusters, without MCOE, and without pine decline reached or exceeded 421 clusters during the 70-year total simulation period (2079).

<u>Forest Decline S3 Scenarios</u>

The loss of habitat by the S3 forest decline scenario reduces the average number of baseline (no-MCOE) RCW clusters at the end of the 70-year simulation period (2079) to 347 (50 Base A20=25 S3), relative to the 460 and 525 active clusters with and without recruitment clusters and no forest decline (Table 10). The baseline population (no MCOE) of 347 clusters with forest decline S3 and 25 clusters in A20 reaches a future population of 421 in eight years by 2087 (50 Post A20=25 S3) on the Installation. The effect of MCOE (Post A20=25 S3) is a much smaller population of 198 clusters at year 2079, requiring 31 additional years to attain the population goal of 421 active clusters in 2110. The post-MCOE population at its recovery size objective in 2110 represents a delay of 23 years compared to 2087 when the baseline population with forest decline S3 attains the size objective. The addition of ACUB fee simple (ACUB) and all ACUB properties to the post MCOE simulations do not, in general, significantly change the forecast future time for the 421 population objective. With the addition of ACUB and all ACUB offsite properties, the future year post-MCOE of attaining the population objective, respectively, is 2111 and 2104 (Table 10).

The addition of all clusters in A20 for recovery management reduces adverse MCOE effects by sustaining a larger population. For a comparison of the effect of all A20 clusters with consistent ACUB properties, the post-MCOE population of 421 clusters is forecast in year 2104 with all ACUB and 25 A20 clusters (Post A20=25 ACUB=All S3), compared to year 2093 with all ACUB and all A20 – an 11 year difference. Interestingly, the simulation with all A20 clusters only reduces the future time required by 11 years. This tends to reflect the fact that large populations can be increased quickly at 2.5% average annual growth. The final 70-year (2079) population in these simulations with 25 A20 clusters is 226, relative to 300 clusters with all A20 clusters. If issues concerning human safety and training conflicts did not exist or were resolvable, the simulation indicates adding and managing all A20 clusters would be a significant enhancement of the Ft. Benning population.

Removing the multipurpose machine gun range in these simulations with all ACUB properties increases the initial population following the 20-year forest decline simulation period, at the beginning the of the 50-year simulation period, from 231 (50 Post A20=All ACUB=All S3) to 258 active clusters (50 Post A20=All ACUB=All S3 no MPMG). The final 70-year (2079) simulated population with all A20 (and all ACUB) without the range is 264 clusters, which reaches 421 by year 2098. Removing the range attains the population goal five years earlier (2098), on average, than without the range (2104).

The previous forecasts of time to the recovery population size objective are based on the average number of active clusters at the end of 70-year simulation period. Effects of forest decline S3 and MCOE delay may be greater or less depending on the variation in the number of active clusters generated by the simulations. For the same baseline population simulation (50 Base A20=25 S3), 90 percent of the values for the number of active clusters were equal to or greater than 296. Conversely, 10 percent of these simulated baseline populations had 296 or fewer active clusters (Table 11). Although less likely to occur than the average, less favorable smaller populations and outcomes are possible. These baseline populations with 296 clusters and S3 decline, occurring with a probability of about 0.10 in the simulations, would attain recovery size objectives by 2093; an additional delay of about six years relative to the 2087 average date. Post MCOE populations of 133 groups (50 Post A20=25 S3), with the same likelihood of occurrence, reach the recovery size objective by 2126 (Table 11) compared to 2111 for the population with the average number of active clusters.

Pine Decline S4 Scenarios

The baseline population without MCOE and with pine decline S4 increases, but declines with the addition of MCOE. No simulations or data are reported for a baseline population with pine decline S4 without any ACUB. Direct comparisons of S4 to other simulations are limited to those with ACUB or all ACUB properties (Table 4-24 and 10). At the end of the 70-year baseline S4 simulation with ACUB fee simple and 20 A20 clusters, the average population is 312 clusters, reaching 421 by year 2091 (Base A20=25 ACUB S4). Compared to pine decline S3 with the same scenario (Base A20-25 ACUB S3), the effect of decline S4 to a baseline population is to delay the population objective by five years, from 2086 to 2091.

There are only three post-MCOE simulations reported or with data for decline S4 for comparison, all with a declining population for the 70-year simulation period. The decline can only be generally attributed to a greater loss of habitat, likely combined with indirect effects of a reduction in RCW group density and the availability of suitable restored habitat. Habitat lost to decline in the 20-year decline scenarios is assumed to be promptly reforested, some of which occurs during the 20-year decline period, and the remaining insufficient habitat during the 50-year simulation period. Restored habitat at age 30, while suitable for foraging, remains unsuitable for cavity clusters until age 60, which is the minimum age considered for longleaf of sufficient size for artificial cavities. Thus, the total 70-year simulation period does not encompass the time for all restored habitat to become suitable for occupancy at potential recruitment clusters.

After the 70-year simulation period, all restored habitat with at least 120 acres becomes suitable for RCW occupancy. It is assumed that the population is capable of increasing after the 70-year simulation period when the absence of habitat no longer is a limiting factor. Future population projections based on a 2.5% average annual growth rate do not, however, account for any spatial limitations due to habitat fragmentation and low density RCW group aggregation. Accordingly, the future projections of time to reach 421 clusters may underestimate growth and time.

The effect of MCOE with ACUB fee simple properties and 25 A20 clusters is a net declining population (-0.32 percent average annual decline, lambda = 0.996) during the 70-year simulation period. There are 95 clusters by 2079, which require an additional 60 years to reach 421 clusters by 2139. This is a 52-year delay relative to the base projection (without MCOE), and is a longer delay relative to the effects of MCOE with pine decline S3. The only other post-MCOE S4 scenario for comparison is the same as above, but with all ACUB properties. The time to reach 421 clusters is year 2143, nearly unchanged from the ACUB fee simple scenario. Adverse effects of MCOE are greater with pine decline S4, causing the longest delays to the 421 cluster recovery size objective (60 years, 2079). Any potential reduction in these effects by removing the multipurpose machine gun range, or including all clusters in A20, was not simulated.

The average number of active clusters with MCOE (50 Post A20=25 ACUB S4) was 93, with a range of 18 to 166 clusters (Table 11). About 10 percent of these 70 simulated populations had been reduced to only 45 active clusters at the end of the 70-year simulation period in 2079 (Table 11), which would require 91 additional years to reach the recovery population size objective in 2170. This likely is an underestimate of the future time to attain 421 active clusters because our deterministic projection from 2079, at the end of the simulation period, does not account for stochastic demographic and environmental variation or the effects of spatial population dynamics as simulated by the SEPM. A reduced population of 45 active clusters is more vulnerable to stochastic variation and fragmentation, increasing the likelihood of local extirpation. Intensive RCW recovery management with recruitment clusters and translocation could be required to augment small, fragmented populations.

Based on the information in this section, the Service concludes that the effects from the proposed project significantly reduced the likelihood of survival and recovery of the Ft. Benning population, and therefore, must assess the SHRU to determine if each population contributing toward the species recovery goals, can off-set the losses accrued at Ft. Benning.

The survival of the Ft. Benning population has become vulnerable in its ability to endure the potential effects from environmental stochasticity. Including the effects of the proposed action, Ft. Benning's population is reduced to about 200 active clusters under the forest decline simulation 3 and to 99 active clusters for forest decline simulation 4 (for clarity, active clusters are not equivalent to PBG's) (Figure 11). When looking at the raw data for the modeling scenarios, the number of active clusters in the Ft. Benning population falls significantly. Of 70 runs, at year 70, and accounting for forest decline, MCOE and 25 groups in the A20 impact area, 10 percent of the runs had between 18 and 43 active clusters remaining. Under the same parameters, 38 percent of the runs had between 18 and 100 active clusters.

Landscape assessment
Stands in the proposed Good Hope Maneuver Area are currently too young to provide a dispersal corridor between clusters south of the A20 Impact Area with clusters east of the impact area and US Hwy. 27-280. The impact area currently provides the most valuable link between RCWs to the south and west with the remainder of the Ft. Benning population; however, approximately 319 acres of it will be impacted by the proposed MPMG2 range. Another 469 acres in A17 would also be cleared for the MPMG2. Clearing for this range will reduce the likelihood of RCWs successfully dispersing to the west. Retention of the remaining active clusters south and west of the A20 impact area will be crucial in order to eventually establish a viable subpopulation in the Alabama portion of the Installation.

Clusters in the southeastern corner of the Installation are also somewhat isolated from clusters to the west by large, young pine plantations. In time, the young plantations can serve as a dispersal corridor to link these clusters with clusters to the west.

There are two groups of clusters that will become vulnerable to demographic stochasticity resulting from habitat loss, reduction of cluster density and isolation from the proposed action: a group of 15 clusters west of the A20 Impact Area and a group of 20 clusters south of the A20 Impact Area. Research on small populations suggests that a minimum of 10 clusters, maximally aggregated, is necessary to keep small populations demographically viable (Crowder et al. 1998, Walters et al. 2002). Based on this research, the two aggregations of isolated clusters in the southwest may persist over time.

Approximately 3,903 acres of habitat and 16 clusters in the northeastern corner of the Installation may be vulnerable to isolation due to lack of contiguous habitat between the corner and the remainder of the Ft. Benning RCW (Figure 12). Aerial surveys conducted in April 2009 confirmed a sufficient dispersal corridor between the Hasting range and the DMPRC to link the northeastern RCW clusters to the nearest active clusters located south of the Kilo impact area (see Figure 2, area labeled "K2). Therefore, the probability of isolation is decreased and those acres and clusters continue to be counted towards Ft. Benning's recovery objective.

Recovery Unit Analysis

All projections for future recovery dates are made by the Service using the best available information. To this extent, the most comprehensive data used is a combination of data derived from the Annual RCW Reports which is a dataset of all managed RCW populations, and various other datasets available to the Service's central reporting official (i.e. the RCW Coordinator).

The RCW Recovery Plan (USFWS 2003) states: "populations required for recovery are distributed among recovery units to ensure the representation of broad geographic and genetic variation in the species. Viable populations within each recovery unit, to the extent allowed by habitat limitations, are essential to the recovery of the species as a whole. Maintaining viable populations within each recovery unit is essential to the survival and recovery of red-cockaded woodpeckers as a species, across their range."

Additionally, conservation of populations in all habitats, forest types, and ecoregions, represented within and by recovery units is critical to species survival and recovery because these varied populations have crucial ecological and genetic values. The loss or reduction of the likelihood of survival and recovery of core and essential support populations within one or more of the designated recovery units could not only jeopardize the recovery goals for the individual recovery unit(s), but also jeopardize the recovery of the entire species.

Therefore, the strategy to recover the red-cockaded woodpecker consists of recovering a number of individual populations - designated as recovery populations - to levels at which they are individually viable against environmental stochasticity. Populations large enough to be resilient to environmental stochasticity will also be able to withstand threats from demographic stochasticity and inbreeding. To be conservative, a number of larger populations (350 potential breeding groups) will exist at the time of recovery. These two population sizes, 250 and 350 potential breeding groups are probably insufficient to avoid loss of genetic variation through genetic drift, at least in the absence of immigration.

However, there are several strategies to reduce the loss of genetic variation as much as possible. First, recovery populations should be increased as far beyond the above population sizes as the habitat base will allow. Second, populations should be recovered as rapidly as possible, because loss of genetic variation increases with the length of time that populations remain small. Third, recovery populations represent the full range of habitat types now occupied by red-cockaded woodpeckers, and this range will aid the conservation of local genetic resources. Finally, dispersal between populations should be facilitated to the fullest extent possible.

When the Service is confronted with assessing project impacts that get to the recovery unit level of analysis, the determination to be made is whether the magnitude of adverse affects appreciably reduces the likelihood of the recovery unit from being able to reach its population goal (USFWS 2005). Information to take into account as this issue is considered includes:

- The SHRU population goal, of which Ft. Benning is a part, is 1050 PBG's.
- Pre-MCOE, the SHRU was projected to attain 1050 PBG's in 2024.
- Pre-MCOE, the projected species recovery date for RCW's, range-wide, was 2085.
- Post-MCOE, recovery on Ft. Benning and consequently the SHRU is estimated to be 2139 which exceeds the species recovery date of 2085.

The status of other properties within the SHRU is relevant when considering the effect of the proposed action on the SHRU. The SHRU has a recovery goal of 1050 PBGs and, pre-MCOE, is projected to achieve this goal in 2024. This date does not account for any habitat limitations. As stated previously, 2085 is projected as the species recovery date. The SHRU has two primary core populations, North Carolina Sandhills East which includes Ft. Bragg, Callaway Tract, Carver's Creek Tract, McCain Tract and Weymouth Woods State Nature Preserve requiring a total of 350 PBGs, and Ft. Benning, also requiring 350 PBGs. There is one secondary core population, the South Carolina Sandhills which is made up of the South Carolina Sandhills National Wildlife Refuge and the Sand Hills State Forest, requiring 250 PBGs. The SHRU also includes one essential support population, North Carolina Sandhills West, which includes Camp Mackall and the Sandhills Game Lands, requiring 100 PBGs at the time of recovery. All of the recovery population goals and estimates assume no significant change happens to forest structure, and all populations will continue to grow at an annual rate of 5% per year due to forest and RCW management applications. Recovery status and projections for each recovery unit and its component properties are included in Table 9.

- North Carolina East/Ft. Bragg et al: – Although the Ft. Bragg population has attained its population goal of 350 PBGs, it has not met the other criteria needed to meet the delisting requirements. In part, the Ft. Bragg RCW population will require many decades to eliminate its dependency on artificial cavities to remain at or above a minimum threshold of 350 PBGs. Additionally, there are no known datasets that express the existing conditions on the number of groups that meet the Good Quality Foraging Habitat (GQFH) criteria. GQFH measures are foundational to validating whether or not the RCW recovery standard for habitat needs is met.

- Ft. Gordon: – Under the current configuration of the RCW Recovery Plan, Ft. Gordon is not part of the recovery goal. Ft. Gordon is considered a significant support population with a population goal of 25 PBGs and is projected to attain its goal at 2019.

- Ft. Jackson: – Like Ft. Gordon, Ft. Jackson is not currently part of the RCW recovery goal, is also considered a significant support population, and has also been projected to be able to attain about 125 PBGs at some time in the future. At the time of this report, however, the Ft. Jackson population is reported to be declining, and there is no analysis to determine when the carrying capacity projection of 125 PBGs might be met.

It is the Service's opinion that the aggregate of impacts (i.e., pine decline and the effects of MCOE) will delay attaining the population and recovery unit objectives of the SHRU. The current forecast for the SHRU to attain its population objective **(pre-MCOE and not considering the effects of pine decline at Ft. Benning)** is 2024. Post-MCOE, including pine decline and the effects of MCOE, the forecast for achieving those goals is 2139, or 115 years later. As stated previously, effects of forest decline on Ft. Benning (S4) without MCOE extent the projected population recovery date to 2091; with the added effects of MCOE, the Ft. Benning primary core recovery population does not achieve its recovery objectives until 2139. The MCOE impacts at Ft. Benning appreciably reduce the likelihood of the Installation's recovery, and the survival of the population is at risk and appreciably reduced. Accordingly, as the population's recovery is delayed, the SHRU's recovery is similarly delayed. Because the RCW Recovery Plan identifies each recovery unit as necessary for survival and recovery of the species; it follows then, that appreciably reducing the likelihood of the SHRU from achieving its recovery goal, would appreciably impair the species' survival and recovery.

RELICT TRILLIUM

The factors to be considered for the relict trillium are much less complex than those for RCWs. Two self-sustaining populations occur on Ft. Benning; they are Randall Creek North and Baker Creek. The Baker Creek site will not be affected; Randall Creek North will incur direct and indirect impacts from this project. The proposed road has been moved from its original alignment so that only the northern-most portion (1.21 acres) of this population will be directly affected (Figure 9; Zone 1). The March 2009 surveys estimated 1,281 stems, or 10.5% of the total 12,254 three-leaved stems, will be damaged by timber harvesting, ground disturbance and/or project construction, as well as the loss of canopy cover. The incident of March 23, 2009, reduced this number by 154 stems so that 9.3% of the total remaining three-leaved stems would be damaged. An additional number of stems will be indirectly affected by forest clearing along a portion of the western edge of the relict trillium population (Figure 9; Zones 5 & 6). These zones are less populated (633 three-leaved stems) than other portions of the Randall Creek North population.

The Army proposes a one-time movement of plants that cannot be avoided during fence or road construction to a recipient site on Ft. Benning or to the Georgia Plant Conservation Alliance Safe Guarding program. Though the expected impacts to trillium will affect 1,127 individuals, the overall effect is relatively small such that no existing population of trillium will be extirpated or reduced below what is considered self-sustaining. Additionally, relocation of stems to a protected area on the Installation or a protected off-Post site may offset some or all of the expected stem loss. Annual monitoring of the populations will continue, including the relocated stems; plus, compliance monitoring will be initiated to ensure construction impacts are minimized (e.g., erosion and sediment controls are functional).

Indirect impact from dust, such as that dispersed by vehicle traffic on dirt or gravel roads, can be detrimental to flowering plants by coating foliage and inhibiting flower pollination. Since the proposed road that will impact the Randall Creek North population will be asphalt, dust should only be a risk during project construction. This risk will be minimized by adherence to construction Best Management Practices per the Georgia National Pollution Discharge Elimination System (NPDES) and Air Rules.

When forested lands are cleared, areas that were once forest interior become the edges of openings. In general, vegetation on the edge of clearings is considerably denser than vegetation in the adjacent forest interior. The increased sunlight and increased probability of disturbed soils cause stand edges to be more susceptible to encroachment from exotic species such as kudzu, Japanese honeysuckle and Chinese privet, as well as aggressive native early-succession plants. These invasive plants will occupy space and compete for light, water and nutrient resources. Invasive species are generally superior competitors and can lead to localized extirpation of native species. The portion of the Randall Creek population adjacent to the forest cleared for the BRAC-related range will be susceptible to reduction due to exotic plant invasion for the life of the range.

Potential indirect effects also include new limits on access and game management because of scheduled training. These effects will persist for the life of the road and range. New and current range SDZs will limit monitoring and management at the trillium sites, such as applying herbicide to control competing invasive plants. Additionally, though feral hogs have not been a problem at this site in the past, the reduced ability to hunt feral hogs and deer in the project area could prompt an increase in browsing that would reduce the reproductive success of relict trillium and lead to a long term decline in viability of this site.

CUMULATIVE EFFECTS

Cumulative effects include the effects of future State, local, or private actions that are reasonably certain to occur in the action area considered in this BO. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the Act.

Actions adjacent to Ft. Benning, such as logging and clear-cutting operations, urban development, and associated activities, will continue to reduce and degrade potential habitat for the RCW and relict trillium. However, there is no State or private land within the action area considered in this consultation. Consequently, the Service did not identify any State or private activities that are reasonably certain to occur within the action area that would constitute cumulative effects.

CONCLUSION

Red-cockaded Woodpecker

In assessing the status of the baseline conditions at Ft. Benning, we used a forest health analysis regarding predicted die-off of pine currently expected to succumb to forest decline syndrome. In assessing the potential impacts of the proposed MCOE on RCWs, we used 1) the Army's biological assessment dated November 2008, and addendums dated March 9 and 23, and May 4, 2009; 2) an analysis using spatially-based demographic data to estimate the ability of the Ft. Benning population to reach its recovery goal of 421 clusters with and without the proposed action; 3) a population viability analysis regarding the potential effects of training; 4) analyses by the Army utilizing a modified version of Walters' demographic model that incorporated parameters to reflect the effects of forest decline syndrome in association with the proposed action and several potential conservation measures; and 5) the RCW Recovery Plan.

The proposed action will remove or degrade approximately 8012 acres of RCW habitat, including cavity trees. Seventy-three active clusters will be directly impacted by habitat loss. One active cluster will be affected by an intensity of construction and training traffic that it is expected to abandon soon after training begins. Another 24 active clusters are expected to suffer harassment levels due to long-term, intensive training activities within 200 ft of the clusters.

This scope of adverse effects is added to a baseline condition that is in a particularly vulnerable status. Currently, less than 25% of the RCW partitions meet the MSS (Managed Sustainability Standard). While RCWs are known to exist under less than the standard conditions, having the majority of the Ft. Benning partitions in a less than sustainable status prior to the implementation of the proposed action exacerbates the adverse effects of the action; particularly when the most current stand structure model forecasts shortcomings in the younger age classes (Table 8). Furthermore, the upland pine habitat upon which the RCW population is supported at Ft. Benning is at risk. The projections regarding stand health and likelihood of death based on crown vigor indicate that about 87% of the loblolly pines will be dead or dying within 15 years. The modeled results, with their best case assumptions, indicate that the Ft Benning population, without adding the effects of the proposed action (i.e., baseline conditions only), can meet its recovery goal after 70 years.

The population viability analyses looked at the potential effects of training on RCWs. The pseudoextinction probability revealed, for the 100 year run at the 200 foot distance, the extinction probability increased from 0.32 to 0.99 with MCOE. Under all distance scenarios, the estimated probability of being classified as vulnerable is greater than 58%; baseline is 58% probability and the 200-ft distance scenario is 90% probability, a 32% increase. Vulnerable is defined as: the probability of pseudoextinction within 100 years is greater than or equal to 0.1 (10%). The probability of achieving the target population at 100 years was reported as pessimistic. Pessimistic is defined as: the probability of achieving the target population is less than 0.1 (10%). For the baseline scenario, the probability of a pessimistic prognosis is 66% and for the 200-ft. scenario the probability of a pessimistic prognosis is 93%, a 27% increase. This modeling provides supporting information for a conclusion that the level of training disturbance would result in an appreciable reduction of the Ft. Benning RCW population.

The results of Walters' original spatially-explicit population modeling (SEPM), which did not account for forest decline effects, indicate that the Ft. Benning RCW population would be reduced by the proposed action and could be back to current numbers (305 clusters) in about 50 years. The result of the modified SEPM run that includes forest decline simulation 4, the effects from the MCOE, 25 managed clusters in the A20 impact area, and ACUB lands is the scenario most likely to occur. This model run suggests that Ft. Benning cannot reach its population objective within the 70-year model time allotment. In fact, the Ft. Benning population which was projected to recover by 2023 exceeds the species recovery date of 2085 as projected in Table 9.

The baseline population without MCOE and with pine decline simulation 4 increases, but declines with the addition of MCOE. At the end of the 70-year baseline simulation 4 with ACUB and 25 A20 clusters, the average population is 312 clusters, reaching 421 by year 2091. The effect of MCOE with ACUB and 25 A20 clusters is a net declining population (-0.32 percent average annual decline). There are 95 clusters by 2079 at the end of the 70-year simulation period, which require an additional 60 years to reach 421 clusters by 2139. This is a 48-year delay relative to the base projection (without MCOE).

The survival of the Ft. Benning population would become vulnerable in its ability to endure the potential effects from environmental stochasticity. Including the effects of the proposed action, Ft. Benning's population is reduced to about 99 active clusters after 70 years, for forest decline simulation 4 (for clarity, active clusters are not equivalent to PBG's). When looking at the raw data for the modeling scenarios, the number of active clusters in the Ft. Benning population falls significantly. Of 70 runs, at year 70, and accounting for forest decline, MCOE and 25 groups in the A20 impact area, 10 percent of the runs had between 18 and 43 active clusters remaining. Under the same parameters, 38 percent of the runs had between 18 and100 active clusters.

A review of the RCW Recovery Plan clearly outlines the contribution of primary core recovery populations to recovery units and, in turn, the species. The SHRU is the second largest recovery unit currently in existence, and pre-MCOE was projected to have been the next recovery unit to reach its population goal. The SHRU contains two of only 13 identified primary core populations; the Fort Benning population is one these primary core populations. The recovery plan speaks to the importance of inland populations due to the inherent vulnerability of coastal populations (in particular, hurricanes and other large wind events), and to the need to recover the species as quickly as possible. The Ft. Benning population recovery date is expected to be delayed; the SHRU recovery is, therefore, also appreciably delayed. The species' recovery date, currently projected for 2085 (Table 9), will also be delayed. Actions that significantly delay recovery, affect survival. The longer a species exists in an endangered state, the longer it is exposed to an increased extinction risk. Thus, a project that significantly delays recovery also appreciably reduces the likelihood of survival.

After reviewing the status of the threatened and endangered species, the environmental baseline, the effects of the action and the cumulative effects, it is the Service's biological opinion that the proposed action exposes this species to threats that are in some cases short-term, and consequently, relaxed rather quickly (pulse effect), but also exposes them to sustained, long-term and chronic threats, in which the effects are not relaxed (press effects), and some effects are permanent, which exposes the species to unprecedented levels of impacts to the point where the species thresholds are in question (threshold effects). It is the opinion of the Service that the frequency and intensity of the training disturbances are so significant, that the accumulating effects of the proposed action will impair the species' ability to recover between disturbances. Finally, it is the Service's view that the action's severity to the species will delay recovery for the species as a whole. The best scientific information available indicates the delay would move the projected date for achieving the species' population objective from 2085 to 2139 (54 years). The delay for the Ft. Benning population, due to the proposed action (i.e., the delay that the action adds beyond the baseline conditions), is 48 years (see modeling results on previous page). Note that the two numbers are not identical because the species' recovery date is not solely a function of the SHRU (see Table 9).

Relict Trillium

The potential direct and indirect effects of the new road, fence and clearing will remove about 9.3% of the Randall Creek North relict trillium adult stems and expose the western edge of Zones 5 & 6 (Figure 9) to increased competition from invasive plants and browsing by hogs and deer. Although the population will be reduced, extirpation of the population is not expected because the densest part of the population will remain intact (Zones 2 to 4). These zones currently contain a minimum of 10,173 stems, which is well above the 500-stem minimum considered necessary for a sustainable population.

Summary

The Service concludes the effects of MCOE are likely to jeopardize the continued existence of the endangered red-cockaded woodpecker; the proposed action, however, is not likely to jeopardize the continued existence of the endangered relict trillium.

In situations where the Service has determined that the action as proposed by the action agency may result in jeopardy to a listed species, the Service can provide an alternate action that if implemented can avoid jeopardy to the listed species. The alternative action needs to meet four specific criteria for implementation by the action agency. For the proposed action, as determined by Ft. Benning Army Installation, the Service provides the following alternative action.

REASONABLE AND PRUDENT ALTERNATIVE

Regulations (50 CFR §402.02) implementing section 7 of the Act define reasonable and prudent alternatives (RPA) as alternative actions, identified during formal consultation, that: (1) can be implemented in a manner consistent with the intended purpose of the action; (2) can be implemented consistent with the scope of the action agency's legal authority and jurisdiction; (3) are economically and technologically feasible; and (4) would, the Service believes, avoid the likelihood of jeopardizing the continued existence of listed species or resulting in the destruction or adverse modification of critical habitat. Because this opinion has found jeopardy, Ft. Benning is required to notify the Service of its final decision on the implementation of the reasonable and prudent alternative.

Our jeopardy determination was based on direct impacts to RCWs via habitat loss and indirect effects from an unprecedented level of training expected to occur over an extended time period. Therefore, the RPA addresses reduction and offsetting of those expected adverse affects. The proposed action would involve loss of 73 active clusters and degradation or removal of 8012 acres of RCW habitat; in addition, approximately 24 active clusters would be indirectly affected (i.e., harassed) due to the long-term occurrence of training activities. This RPA has components, all of which must be implemented in full to remove the likelihood of jeopardy to the species.

- Remove the machine gun range in the A17 and A20 impact areas. Elimination of this project component avoids the loss of four active clusters and 788 acres (469 acres in A17 and 318 acres in A20) and the isolation of two groups of clusters (20 and 11 active clusters, respectively) in that area from the RCW population.

- Manage 36 additional active clusters in the A20 impact area that are not currently counted toward recovery. All clusters not currently managed (57 in 2009) in the A20 impact area (active and inactive) will be monitored aerially to determine number of active or suitable cavities per cluster. (This does not include the 14 clusters that are currently managed). Any aerially monitored cluster with at least 4 active cavities can be counted towards the 36 A20 active clusters that are required to satisfy this component of the RPA. For clusters containing less than 4 active or suitable cavities, as defined above, ground access to a sufficient number of these for artificial cavity insertion would be required to reach a minimum number of 36 managed clusters. Conversely, if 36 aerially monitored active clusters contained 4 active cavities as defined above, in a given year, then no on-the-ground access would be required for that year. Inclusion of these clusters in RCW management and monitoring activities will enable Ft. Benning to count them toward the Installation's recovery goal (i.e., where there are PBGs) and provide an offset for the direct impacts to 73 active clusters resulting from the proposed action. The obligations that accompany these groups are:
    - The ability to conduct A20 annual cluster surveys during the Spring (March 1 to April 30) to aerially identify active clusters, each of which must have at least 4 active cavities, or by ground surveys of which each active cluster must have 4 suitable cavities. Active clusters surveyed on-the-ground (e.g., the 22 clusters to be accessed in 2009 and 2010) during breeding season will also be assessed for the presence of PBGs.
    - Ground access, during the Fall/Winter, to install artificial cavities as appropriate to maintain at least 4 suitable cavities in each accessed cluster. On-the-ground cluster and cavity tree status assessments (active and/or suitable) will also be conducted at all clusters accessed on-the-ground during these "cavity management" visits.
    - Annual examination, via aerial and/or ground surveys, of all clusters and active cavity trees in the A20 monitored clusters to assess nesting habitat conditions (e.g., presence of midstory) and to determine the status (live, dead, damaged) of each cavity tree. Examinations will be conducted during the breeding season.
    - Control of hardwood midstory, as necessary, via application of appropriate herbicides and/or prescribed fire.
    - Control of fire fuel loads by prescribed fire, including aerial and/or ground ignition as necessary, to reduce and avoid cavity tree mortality.
    - Development, in coordination with the Service, of an A20 Cluster Management Plan within six months of the date of adoption of the RPA, to include tasks such as delineation of clusters, a trigger (e.g., number of clusters above 36) to prompt planning for ground access management, and protocols for dealing with emergencies (e.g., wild fire, tornado damage).

- Migrate the field training aspects of the Scout Leaders Course (Army Reconnaissance Course), a MCOE-related heavy mechanized training course, from the Southern Maneuver

Training Area to training areas located off the FY09 Ft. Benning installation boundary within five years from the training start date of the Scout Leaders Course. The long-term effects of intensive training within and near the Southern Maneuver Training Area will impact 13 clusters. In addition, one cluster will be impacted by increased traffic between Harmony Church and the Southern Maneuver Area. Moving the field training aspects of the SLC/ARC mechanized activities to a training area(s) located off the FY09 Ft. Benning installation boundary where RCWs do not occur will remove these effects. Other training will continue in the Southern Maneuver Area in accordance with the Management Guidelines for the Red-cockaded Woodpecker on Army Installations (1996) because of the management measures identified in these guidelines, adverse effects are not likely. The Army, in coordination with the Service, will develop a Training Migration Plan within six months of the date of adoption of the RPA. The Training Migration Plan will address performance standards and milestones for progress.

- Rescope projects to avoid impacts. Rescoping of the following projects avoids the loss of 12 RCW clusters and 1406 acres of potential RCW habitat:
  a) The adverse impacts of the Southern Maneuver Area have been reduced from 22 clusters (13 direct, 9 indirect) and 3036 acres of potential RCW habitat to 13 clusters (7 direct, 6 indirect) and 1871 acres affected.
  b) The adverse impacts of the 19 K/D OSUT Maneuver Area have been reduced from 6 clusters and 329 acres of potential RCW habitat to 5 clusters and 180 acres affected.
  c) The adverse impacts of the Repair Existing Training Area Roads have been reduced from 5 clusters and 209 acres of potential RCW habitat to 4 clusters and 194 acres affected.
  d) The adverse impacts of two ranges in the Oscar Complex, Z2 and MRF7, have been reduced from 1 cluster and 108 acres of potential RCW habitat to 0 clusters and 33 acres affected.

The RCW spatially explicit individual-based model (SEPM) simulations prepared by Army and collaborators during the model workshop were prepared to evaluate and compare various baseline (pre-MCOE) forecasts of future RCW population size, distribution, and growth relative to effects of forest decline and MCOE. We would like to use similar models to assess the effects of the RPA on these same parameters, but the models do not include sets with and without the RPA for direct comparison. Elements of the final RPA were developed after the models were produced and evaluated. Effects of the RPA were estimated using these models, although these comparisons are not the direct outcome of the model simulations.

The projected recovery date for the RCW at the species level is 2085 (see formula and projections on Table 9). Prior to implementing the RPA and utilizing the newly derived recovery projections, the proposed action would have delayed the species recovery by 54 years. With the RPA in place, species recovery is achieved five years sooner (i.e., a 49-year delay). This projection was reached via similar modeling used in analyzing project effects based on the formula: Post-MCOE at 112 active clusters, S4, A20=36, 2.5 annual growth rate and a ratio of active clusters to PBGs at 1.12:1, or the average ratio of active clusters to PBGs rangewide. This calculation does not account for the potential of additional habitat degradation beyond the S4 parameters and is not spatially referenced. Using similar formulae, the RPA was individually assessed to examine how it reduced the effects of the action. With the RPA implemented, the Ft. Benning population is delayed 43 years, and the baseline conditions on Ft. Benning, which in this case, is significantly affected by pine decline syndrome, delays the population recovery objective by 51 years.

Despite the limited improvement to the modeled recovery timeline, the RPA will remove the likelihood of jeopardy. The effects of the RPA avoid the net direct MCOE loss of 73 active clusters, reducing the direct adverse effects to a net loss of 21 clusters. This is achieved by avoiding incidental take of four clusters upon the removal of the machine gun range and 12 clusters by re-scoping certain MCOE actions, for a total of 16 clusters. The addition of 36 clusters managed in the A20 impact area is a compensatory effect to the 57 remaining clusters lost by MCOE (73-16=57), reducing the net direct loss to 21 active clusters (57-36=21). The available post-MCOE spatially-explicit models did not include the 12 clusters otherwise protected by the RPA, which assumed at the time of the simulations that these 16 would be adversely affected. Also, the post-MCOE models with A20 were based on 25 managed recovery clusters in the impact area, and not the 36 required by the RPA. Furthermore, no model simulated the indirect effects or the subsequent reduction.

By eliminating the expected loss of active clusters in the MPMG footprint, the likely fragmentation of the population and creation of small, isolated sub-populations in that southwest area of the Installation is also eliminated. Managing 36 active clusters in the A20 impact area does not eliminate the direct take of 57 active clusters but allows the 36 clusters to be counted toward Ft. Benning's recovery goal. Currently, these groups are part of an ITS and could legally be destroyed at any time. The portion of the RCW population in the A17 and A20 impact areas represents the stronghold of the Ft. Benning population with the best RCW habitat (old trees, frequently burned). Figure 13 is a representation of the RCW clusters on Ft. Benning before and after the MCOE including the anticipated effect of the RPA.

Additionally, the RPA would eliminate the long-term, chronic effects of heavy mechanized training on 17 of the 24 active clusters. Migration of heavy mechanized training five years after training begins will eliminate the long-term chronic effects of that training. The productivity of these clusters and the population is expected to improve. Fewer years of exposure to impacts is expected to reduce the intensity, frequency and duration of harassment of RCWs. It is our expectation that the 17 active clusters that would be subjected to the initial five years of training impacts will quickly recover from any negative effects that may have incurred and once again contribute to the growth of the population.

Therefore, the Service believes that the implementation of: 1) the RPA, 2) the entirety of the conservation measures proposed by the action agency in the MCOE BA, and 3) the succeeding reasonable and prudent measures and terms and conditions, will reduce the impacts of the proposed MCOE such that the likelihood of survival and recovery will not be appreciably reduced.

INCIDENTAL TAKE STATEMENT

Section 9 of the Act and Federal regulation pursuant to section 4(d) of the Act prohibit the take of endangered and threatened species without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harm is further defined by the Service to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering. Harass is defined by the Service as intentional or negligent actions that create the likelihood of injury to listed species to such an extent as to significantly disrupt normal behavior patterns which include, but are not limited to, breeding, feeding or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the Act provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement.

The measures described below are non-discretionary, and must be undertaken by Ft. Benning for the exemption in section 7(o)(2) to apply. Ft. Benning has a continuing duty to regulate the activity covered by this incidental take statement. If Ft. Benning fails to assume and implement the terms and conditions, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, Ft. Benning must report the progress of the action and its impact on the species to the Service as specified in the incidental take statement. [50 CFR §402.14(I)(3)]

Sections 7(b)(4) and 7(o)(2) of the Act generally do not apply to listed plant species. However, limited protection of listed plants from take is provided to the extent that the Act prohibits the removal and reduction to possession of federally-listed endangered plants or the malicious damage of such plants on areas under Federal jurisdiction, or the destruction of endangered plants on non-Federal areas in violation of State law or regulation or in the course of any violation of a State criminal trespass law.

AMOUNT OR EXTENT OF TAKE ANTICIPATED

The Service has developed the following incidental take statement based on the premise that the reasonable and prudent alternative will be carried out. The Service anticipates incidental take in the form of harm and harass of the endangered red-cockaded woodpecker. Fifty-seven active clusters will be taken in the form of destruction or degradation of habitat, 14 active clusters will be taken in the form of short-term disturbance, and 7 active clusters will be taken in the form of long-term disturbance.

EFFECT OF THE TAKE

In the accompanying biological opinion, the Service determined that this level of anticipated take is not likely to result in jeopardy to the species, or destruction or adverse modification of critical habitat when the reasonable and prudent alternative is carried out.

REASONABLE AND PRUDENT MEASURES

The Service is providing additional non-discretionary measures to minimize incidental take other than those in the project description and the reasonable and prudent alternative. We are assuming the conservation measures included in the proposed action will be implemented as described; particularly, related to monitoring the effects of the proposed action (see Table 11). We also are providing terms and conditions for some of the minimization measures provided in the biological assessment.

1. Shift cluster centers by provisioning artificial cavities to minimize project-related cavity tree impacts or harassment impacts, primarily related to road construction and use.

2. In coordination with the Service, develop a monitoring plan by the end of October 2009 for RCWs affected by heavy maneuvers.

TERMS AND CONDITIONS

1. A plan to shift cluster centers will be developed by the end of October 2009 to be approved by the Service. This plan will include a protocol for shifting cluster centers and the projected completion date.

2. The monitoring plan for heavy maneuver effects must quantify and compare the response of subjected RCWs to those not subjected to maneuver disturbance. The Service and Army will meet at least annually, or more often as circumstances dictate, during the monitoring period to review the data and evaluate methods or opportunities to reduce adverse effects. As heavy maneuver areas are thinned, pre-harvest data should be collected to inform causal relationship of any effects to RCWs.

3. Associated with the Ft. Benning review process, Section 8.1, USACE, 2008.

The Service should be included in the NEPA review process; i.e., the FB Form 144-R process for all projects related to forestry and RCW management.

4. Associated with the environmental awareness training program, Section 8.3, USACE, 2008.

The environmental awareness training program should be expanded to include contractors and other entities working on Ft. Benning. Participation in the awareness program should be documented to confirm exposure to the information related to conservation of listed species.

5. Associated with reporting on taken clusters with potential to meet the Ft. Benning modified MSS, Section 9.2.4, USACE, 2008.

Reports for post-FHA (foraging habitat analysis) improvements should remain consistent with what has been outlined in the BRAC BO (USACOE 2007b) and should include;

i). delivery of the post-FHA report at least one month prior to initiation of the proposed action,

ii). clearly identify the pre-project FHA limiting factors, and subsequently, quantify the post-treatment measures, and
iii). provide pre- and post-project photographs that best represent the stand condition.

6. Associated with habitat monitoring, Section 9.4, USACE, 2008.

The Habitat Impact Assessment Plan should be completed by July 2009, and prepared in coordination, and with the approval of, the Service.

7. Associated with compliance monitoring, Section 9.5, USACE, 2008.

The Service will be notified of incidences of non-compliance with training restrictions within 24 hours; particularly, where impacts to federally-listed species are known or suspected.

8. Associated with berming of small arms ranges, Section 9.7, USACE, 2008.

Reports on the effectiveness of small arms range berms that are constructed to minimize the effects of the action and are partially placed to protect RCWs and their habitat, will be developed in collaboration with on-site Service personnel. The reports should include, but are not limited to;

i). If Ft. Benning staff discovers munitions damage in RCW clusters and/or foraging habitat as a result from firing on any small arms range, the Service will be notified within 24 hours of the discovery,
ii). Habitat monitoring reports for small arms ranges will be submitted to the Service at the end of each week during the breeding season and monthly otherwise.

9. Within six months of completion of consultation, collaborate with the Service to develop a plan for wildfire response in order to provide accountability for decisions made to let a fire burn. The plan would be specific to the A20 impact area and the clusters that will be counted toward recovery.

10. Provide the Service with monthly briefings of project and management status. The Army and Service will coordinate on the specific information that will be addressed at the monthly briefings.

Upon locating a dead, injured, or sick individual of an endangered or threatened species, initial notification must be made to the Fish and Wildlife Service Ecological Services Sub-Office at Ft. Benning, Georgia (706-544-6030). Care should be taken in handling sick or injured individuals and in the preservation of specimens in the best possible state for later analysis of cause of death or injury.

The reasonable and prudent alternative is designed to eliminate jeopardy and to minimize the impact of incidental take that might otherwise result from the reasonable and prudent alternatives and proposed action. The Service believes that take in the form of group persistence as it relates to available habitat, and harassment of individual and groups of birds due to acute and chronic disturbance from training, as described in the above analysis, will be incidental. If, during the course of the action, this level of incidental take is exceeded, such incidental take represents new information requiring reinitiation of consultation and review of the reasonable and prudent measures provided. Ft. Benning must immediately provide an explanation of the causes of the taking and review with the Service the need for possible modification of the proposed action or the reasonable and prudent alternatives.

COORDINATION OF INCIDENTAL TAKE STATEMENTS WITH OTHER LAWS, REGULATIONS, AND POLICIES

Migratory Birds

The Fish and Wildlife Service will not refer the incidental take of any migratory bird for prosecution under the Migratory Bird Treaty Act of 1918, as amended (16 U.S.C. §§ 703-712), if such take is in compliance with the terms and conditions specified above.

CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the Act directs Federal agencies to use their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help carry out recovery plans, or to develop information. In order for the Service to be kept informed of actions minimizing or avoiding adverse effects, or benefiting listed species or their habitats, the Service requests notification of the implementation of the conservation recommendations carried out.

Red-cockaded Woodpecker

1. Convene a group of RCW and forest management experts to assist the Army in developing a plan to reforest Ft. Benning while maintaining a primary core recovery population.
2. Coordinate with the Service regarding modified burn return intervals in order to minimize the rate of pine mortality.
3. Thin entire stands upon entry to address foraging habitat deficiencies for specific partitions.
4. Dedicate ACUB land to RCW management including a focus on creation of a contiguous corridor of habitat between Ft. Benning and all ACUB lands.
5. Comprehensively assess future ACUB or other RCW potential conservation properties using spatially explicit individual-based RCW models, with pattern oriented modeling, to reduce model uncertainty and to assess demographic functions relative to the population on the Installation.
6. Initiate research to assess RCW fitness, actual home range, habitat quality and quantity within home ranges, and foraging behavior and selection in home ranges. Compare habitat quality and quantity in home ranges to matrix partitions, and the extent that partitions represent actual territories.
7. Delay recruitment until a management team is convened to create a plan that accounts for growing a sustainable forest.

Relict Trillium

To offset the direct effects of project construction Ft. Benning should:

1. Coordinate and contract the translocation of all relict trillium from the foot print of this project with the Georgia Plant Conservation Alliance (GPCA) or a GPCA affiliate.
2. Monitor the donor site for indirect effects of the action; monitor the recipient site for viability of the translocated stems.
3. Secure any recipient site fee simple purchase or permanent conservation easement.

To offset indirect effects of project construction, Ft. Benning should:

1. Complete a relict trillium management plan, indicating management actions at each known population on Ft. Benning, to be coordinated through GPCA or an affiliate.
2. Construct an exclusion fence around the entire Randall Creek North population.
3. Conduct annual invasive species monitoring within the Randall Creek North population and conduct suppression of invasive species as needed.
4. Create and maintain a fire break or range road between the proposed ranges and the Randall Creek North population to prevent frequent fires.

REINITIATION NOTICE

This concludes formal consultation on the action outlined in the November 4, 2008, request. As provided in 50 CFR §402.16, reinitiation of formal consultation is required where discretionary Army involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount of incidental take is exceeded; (2) new information reveals effects of the agency action that may affect listed species in a manner or to an extent not considered in this opinion; (3) the agency action is subsequently modified in a manner that causes an effect to the listed species not considered in this opinion; or, (4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, any operation causing such take must cease pending reinitiation of consultation. Because the likelihood of establishment of new groups or cavity trees increases over time, the Service strongly recommends that the Army conduct a RCW survey within the year of start of construction for MCOE projects. New groups or cavity trees that may be impacted by the proposed project represent new effects of the action not considered in this opinion, and would require reinitiation of consultation.

Discussions during the course of this consultation highlighted the need for the Army to proceed with revision of the Ft. Benning Integrated Natural Resource Management Plan (INRMP) which would include updating the Endangered Species Management Plan. Our consultation on the INRMP revision would also review impacts of ongoing training such as that associated with the 3rd Brigade which has not been consulted on previously. Updating the INRMP would additionally provide opportunity for Ft. Benning to operate under the 2007 Armywide Guidelines, which are less restrictive than the 1996 Armywide Guidelines Ft. Benning currently operates under.

For this biological opinion the incidental take would be exceeded when the take exceeds the 57 active clusters expected to be directly taken and 24 active clusters to be indirectly taken. These RCW groups are exempted from the prohibition of section 9 by this opinion.

The Service greatly appreciates the cooperation of Ft. Benning during this consultation. We would like to continue working with you and your staff regarding this project. If you have any questions about this opinion or consultation or for further coordination, please contact John Doresky, Fish and Wildlife Biologist, West Georgia Sub Office, at (706) 544-6030.

Respectfully,

Sam D. Hamilton
Regional Director

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Appendix A—Figures (*electronic files are separate from biological opinion*)

Figure 1. The action area, including the Installation and affected adjacent lands is 216,748 acres. The portion of the action area outside of the Installation boundary, but within the RCW neighborhood, includes portions of Chattahoochee, Marion, Muscogee and Talbot Counties, Georgia.

Figure 2. Northern Ranges, Oscar Complex, Northeastern Ranges, Southern Maneuver Area, and Southern Ranges.

Figure 3. Current and proposed Heavy Maneuver Area use, excluding surface danger zones (SDZs), impact areas and other exclusion areas as designated by Range Division.

Figure 4: Potential ACUB lands (80,000 acres) (Source: TNC).

Figure 5: Range wide distribution red-cockaded woodpecker.

Figure 6: A20 Clusters.

Figure 7. Location of red-cockaded woodpecker (RCW) populations within the Sandhills Recovery Unit (USFWS 2003a).

Figure 8. Pine Decline Risk Map for Fort Benning showing the risk of decline if areas are forested in loblolly or shortleaf pine (Louisiana State University Agricultural Center, 2004).

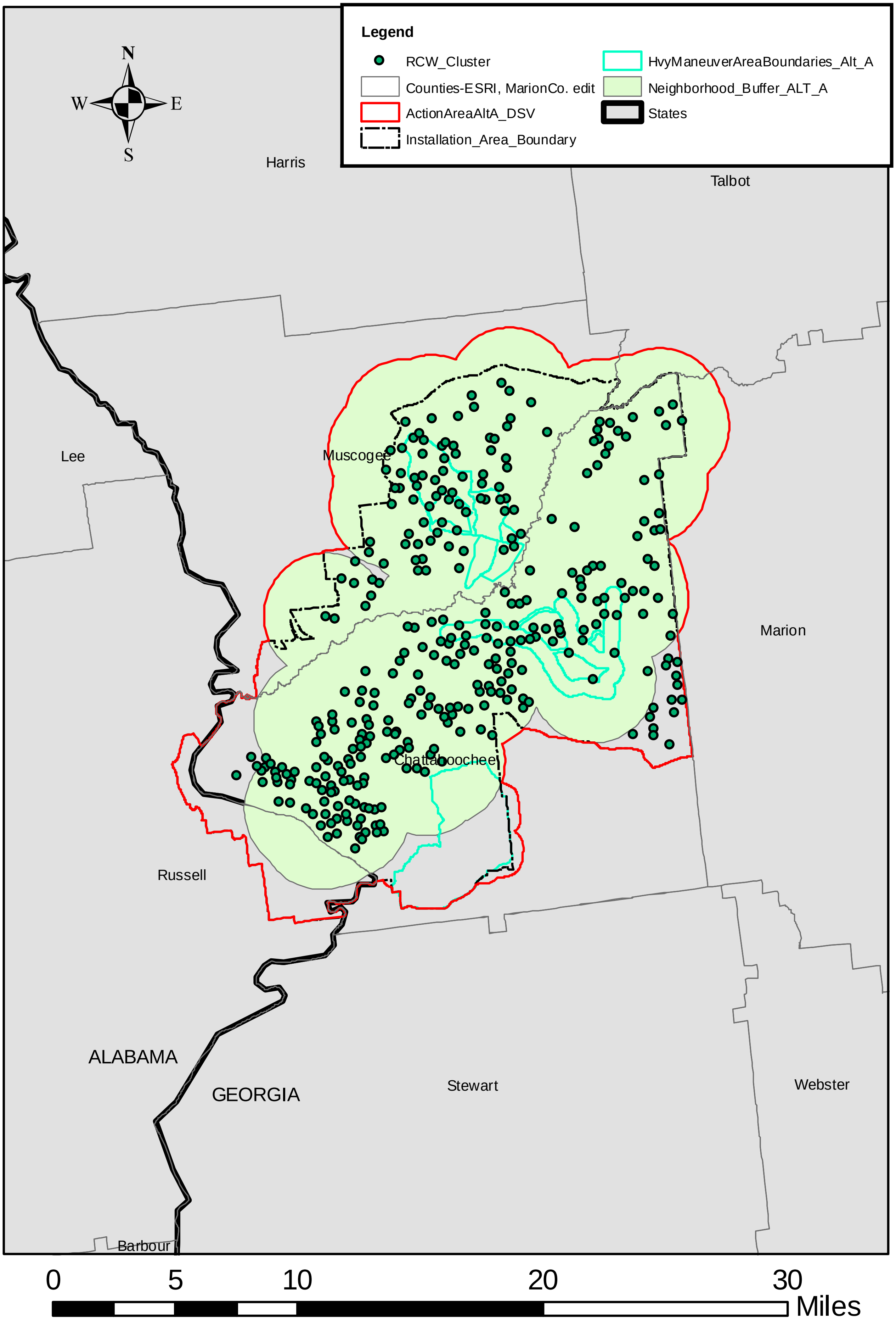
Figure 9. Randall Creek relict trillium population, Ft. Benning, Georgia (source:USACE 2009).

Figure 10. Randall Creek relict trillium population, Ft. Benning, Georgia (source:USACE 2009).

Figure 11. Comparison of baseline and post-MCOE 50-year model simulations (Source: USACE 2009).

Figure 12. Depiction of RCW cluster vulnerabilities represented as rate of cluster abandonment. Note significant vulnerabilities along eastern boundary.

Figure 13. (a) Post-project status of red-cockaded woodpecker (RCW) clusters after cluster, group (1.25 mile radius) and neighborhood (2.57 mile radius) analyses and (b) post-project density of RCW clusters, RPA analysis, Fort Benning, Georgia.



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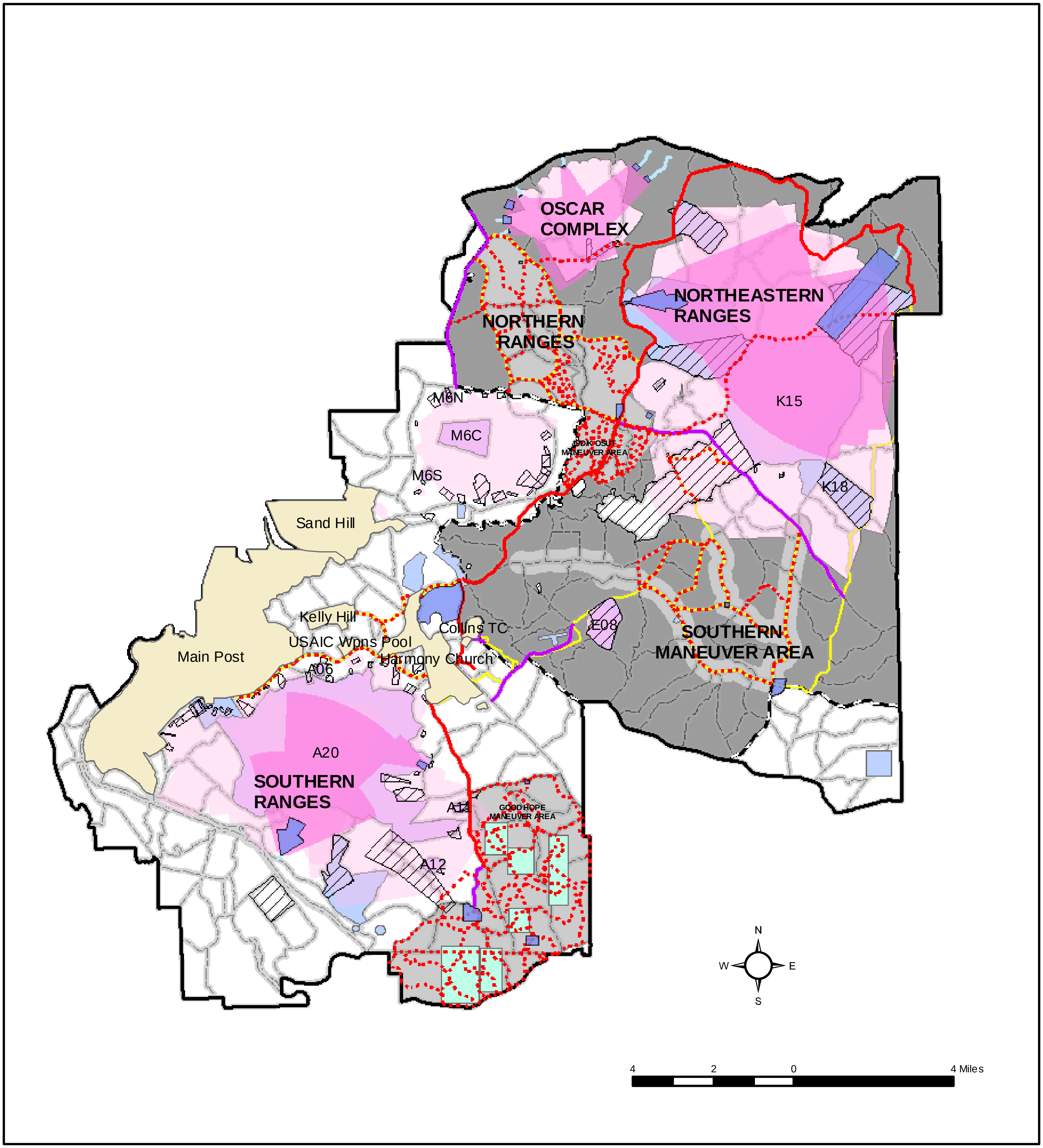


Figure 2. Northern Ranges, Oscar Complex, Northeastern Ranges, Southern Maneuver Area, and Southern Ranges.

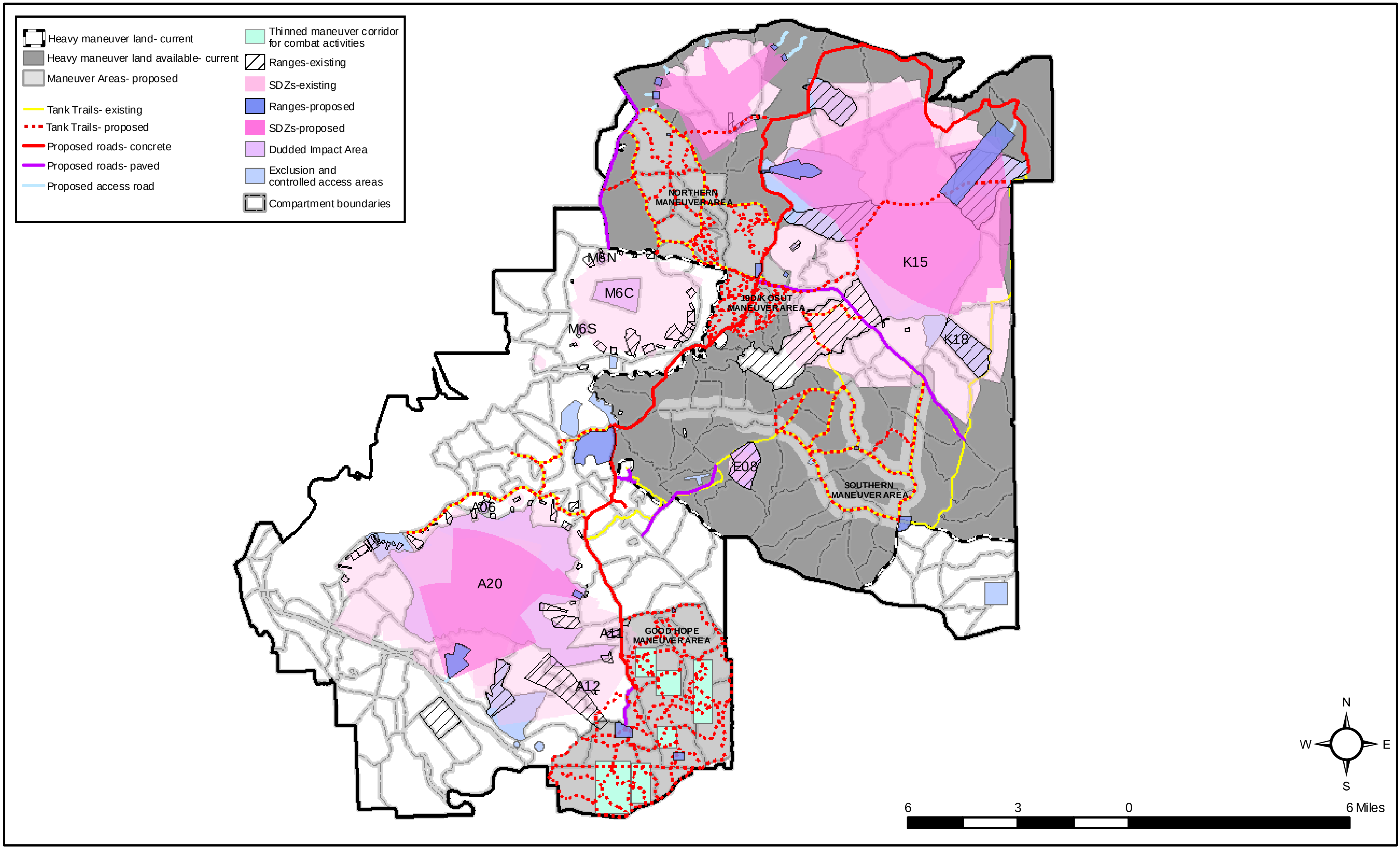
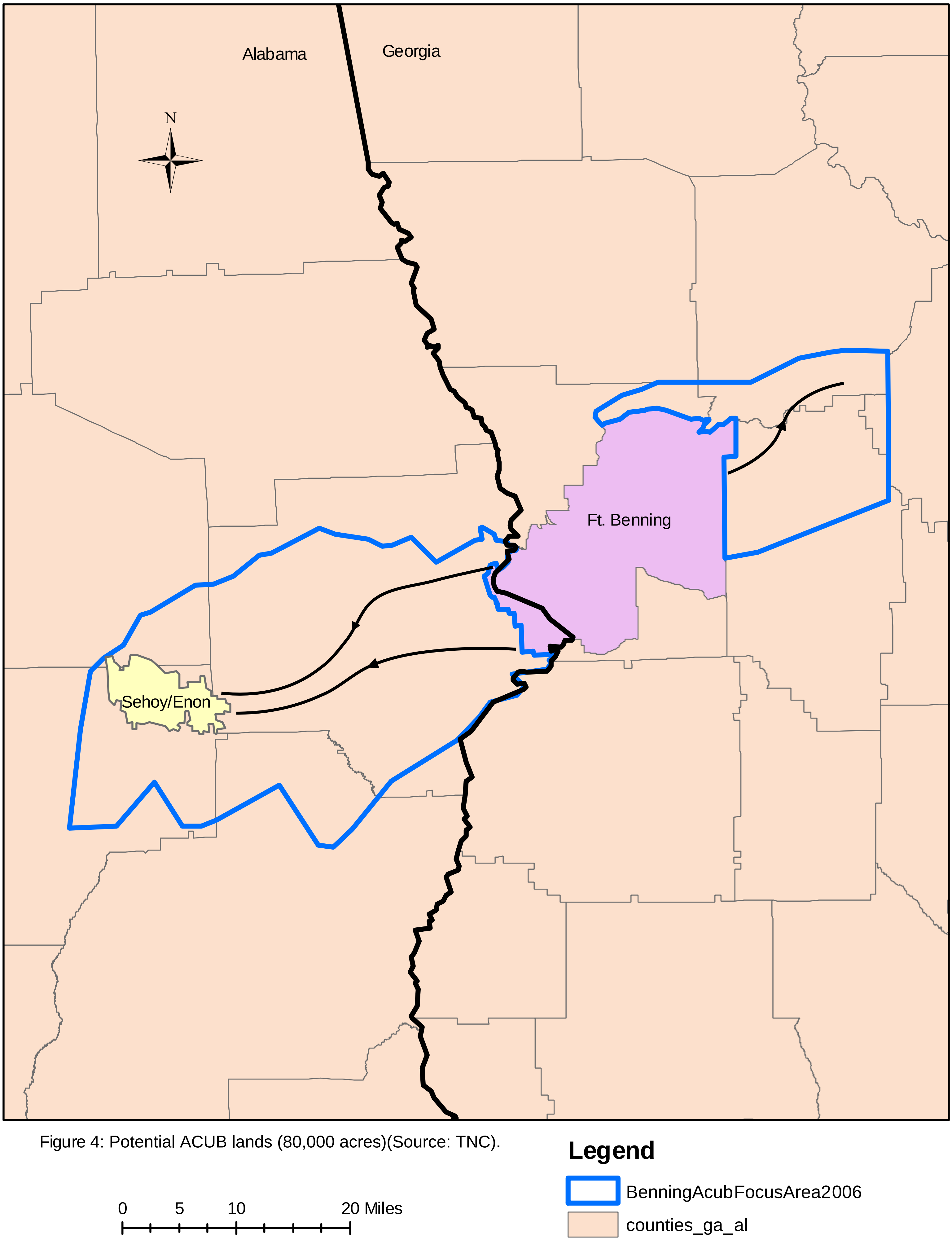


Figure 3. Current and proposed Heavy Maneuver Area use, excluding surface danger zones (SDZs), impact areas and other exclusion areas as designated by Range Division, Alternative A (Preferred Alternative) for the Maneuver Center of Excellence, Fort Benning.



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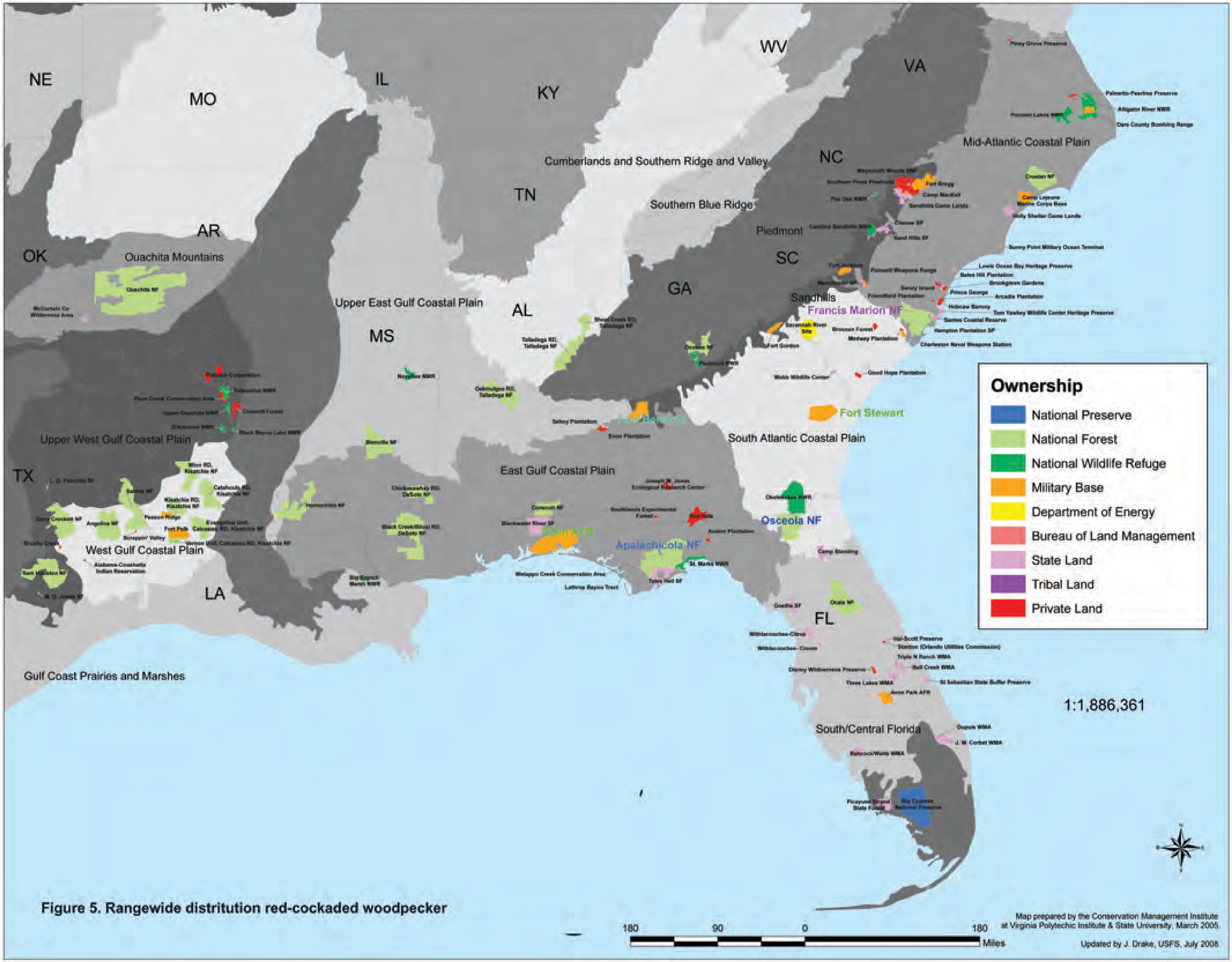


Figure 5. Rangewide distritution red-cockaded woodpecker

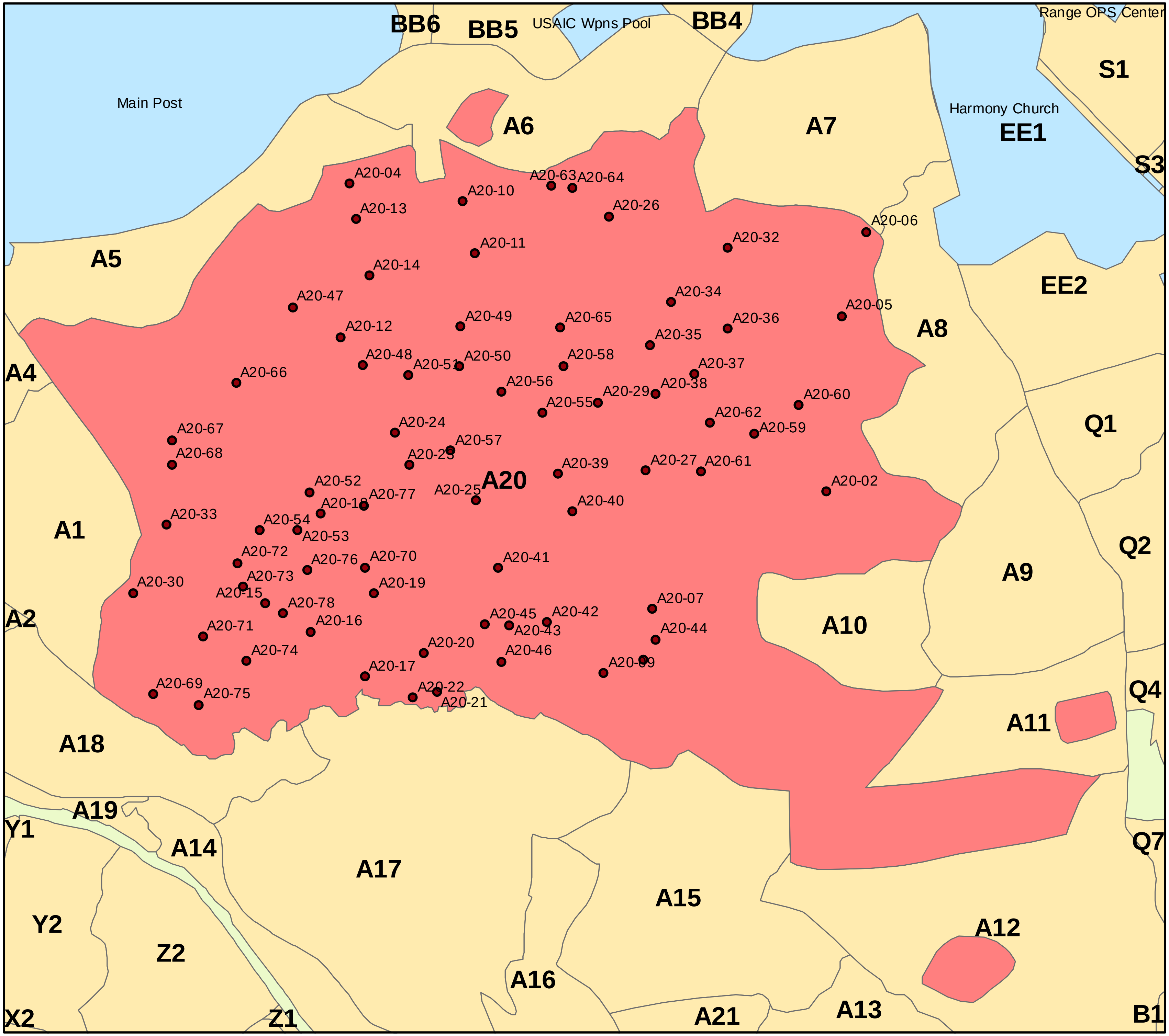


Figure 6: A20 Clusters.

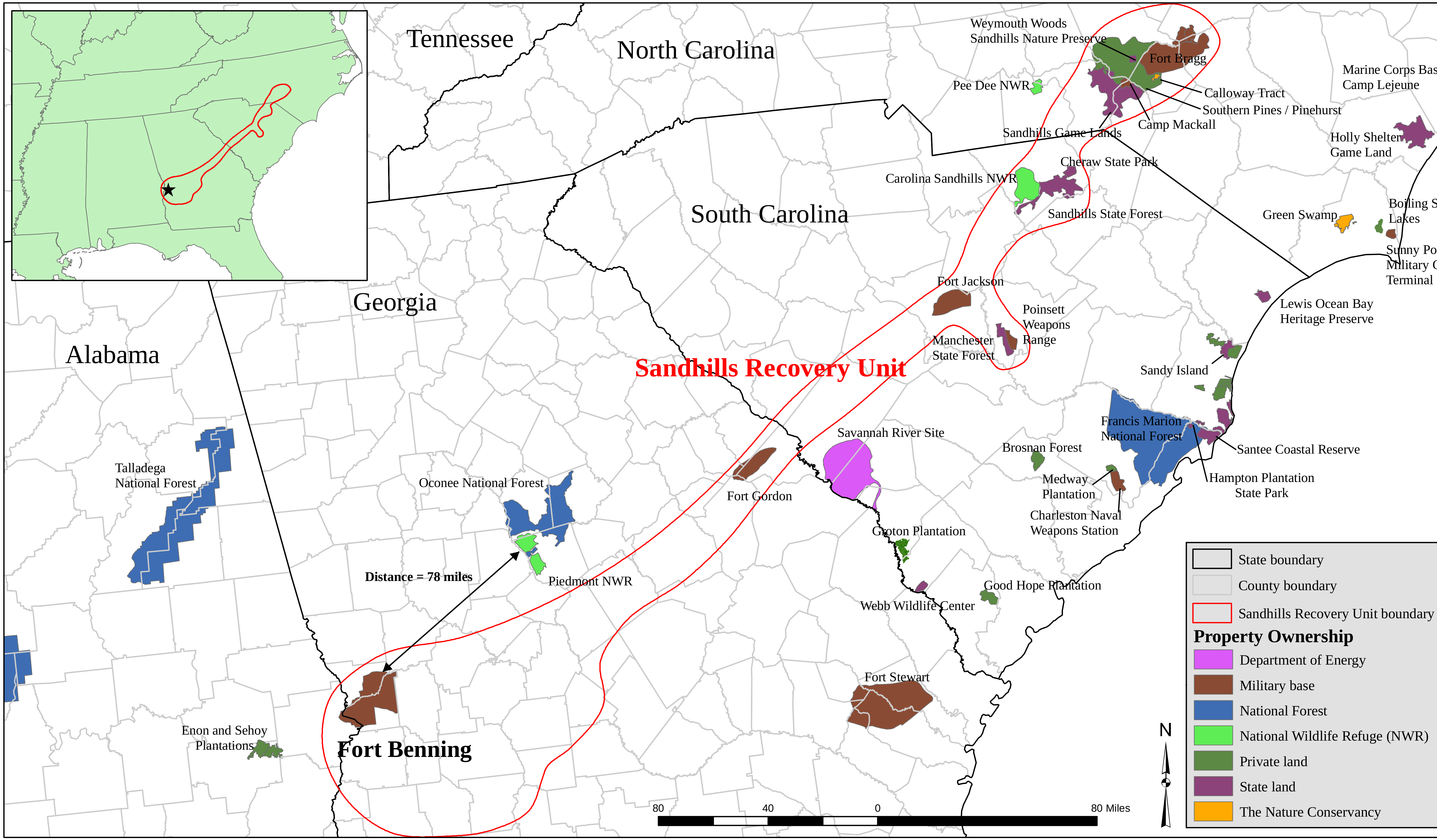
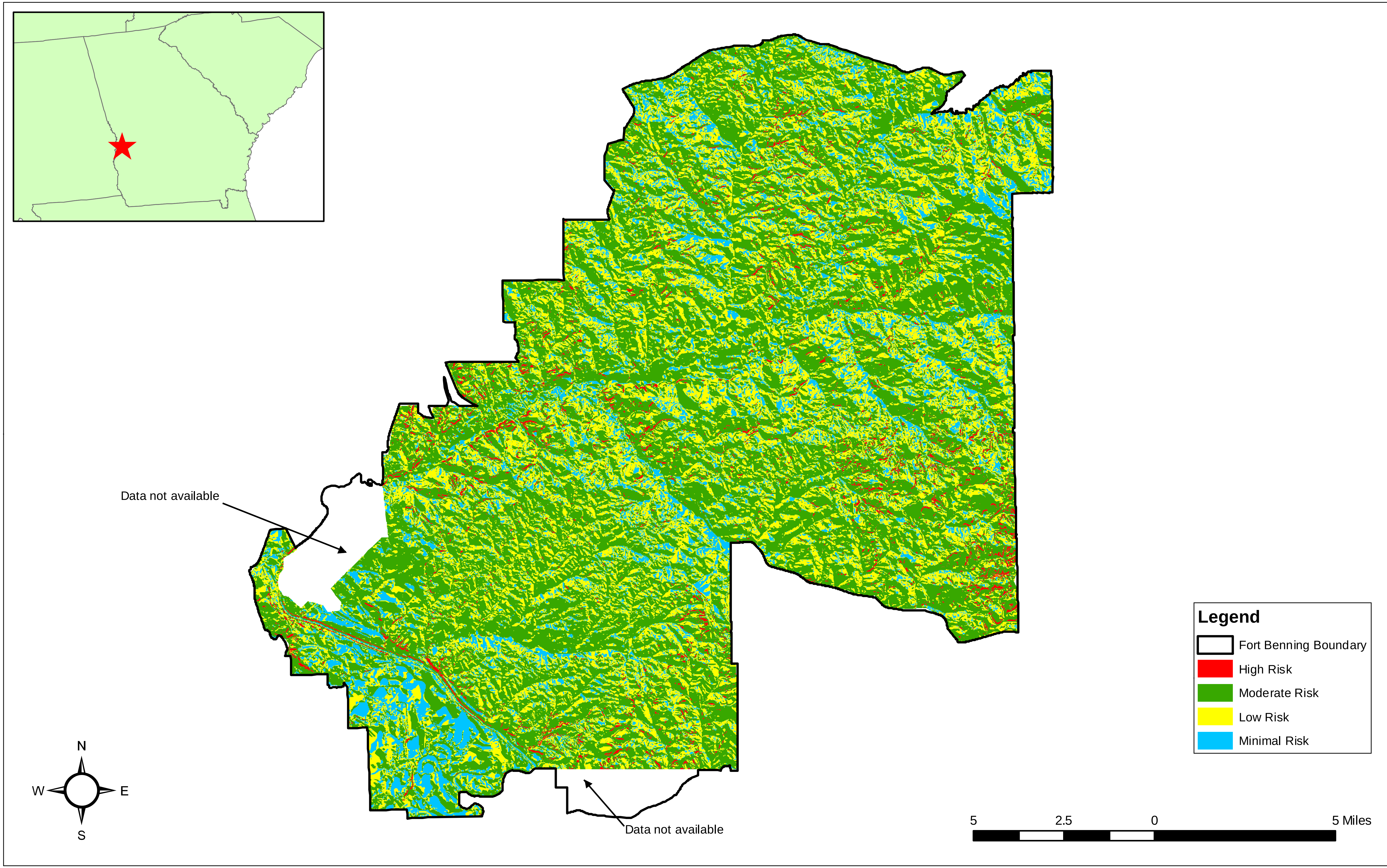


Figure 7. Location of red-cockaded woodpecker (RCW) populations within the Sandhills Recovery Unit (USFWS 2003a). This map also shows the distance between the Piedmont National Wildlife Refuge RCW population and Fort Benning.



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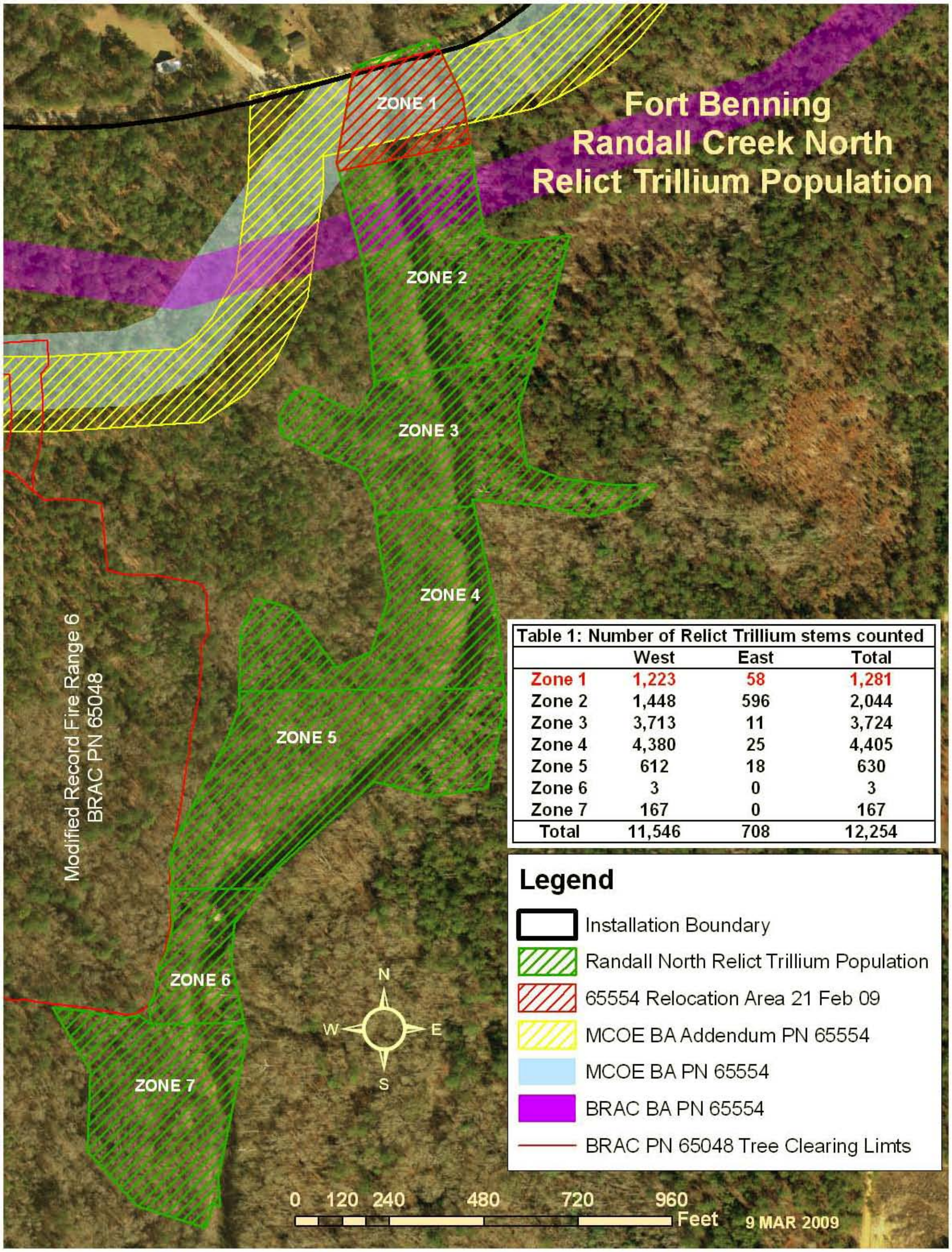

Table 1: Number of Relict Trillium stems counted

	West	East	Total
Zone 1	1,223	58	1,281
Zone 2	1,448	596	2,044
Zone 3	3,713	11	3,724
Zone 4	4,380	25	4,405
Zone 5	612	18	630
Zone 6	3	0	3
Zone 7	167	0	167
Total	11,546	708	12,254

Figure 9. Randall Creek relict trillium population, Ft. Benning, Georgia (source:USACE 2009).

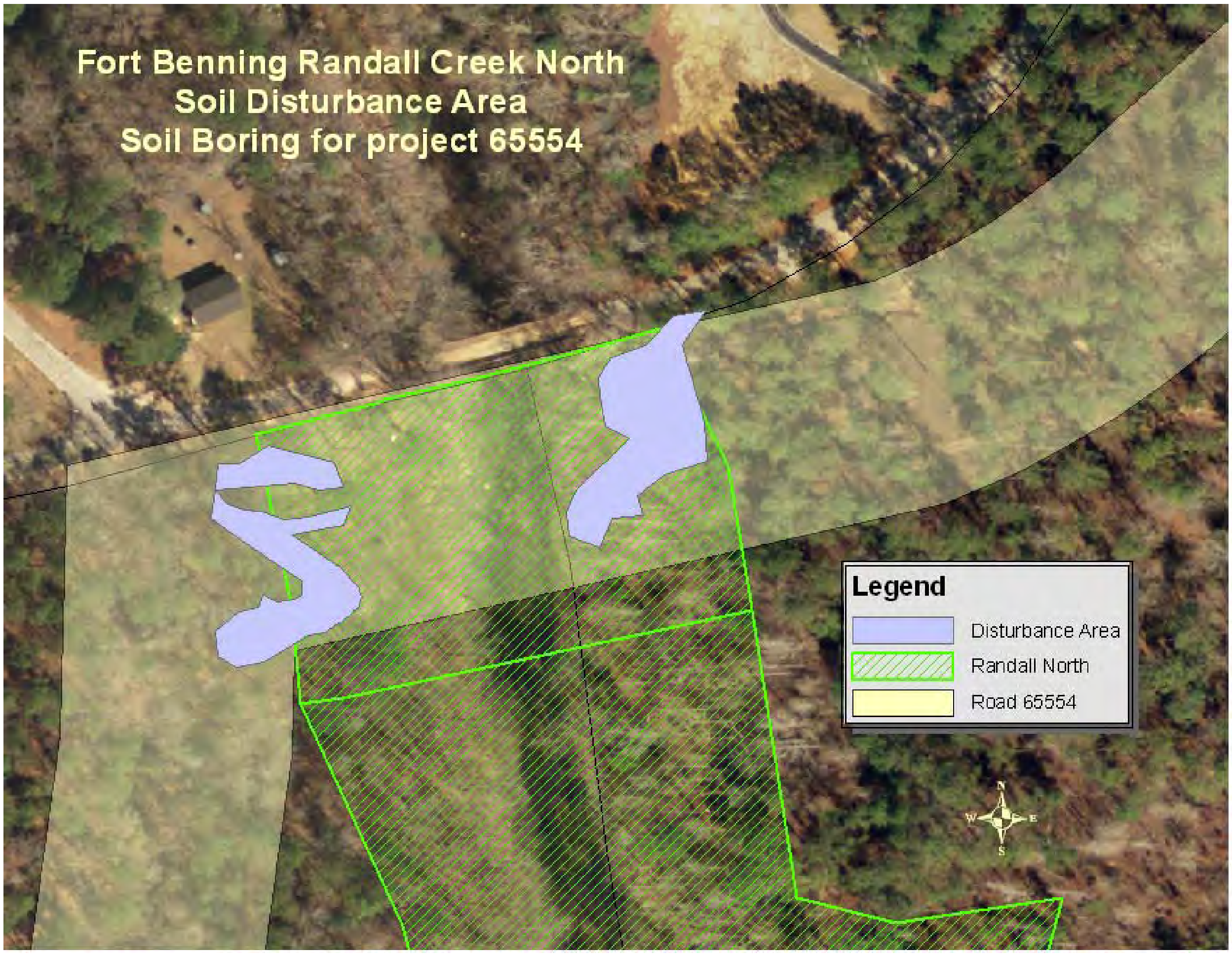

Figure 10. Limits of disturbance at Randall Creek North relict trillium site, March 23, 2009 (Source: Fort Benning, Conservation Branch)

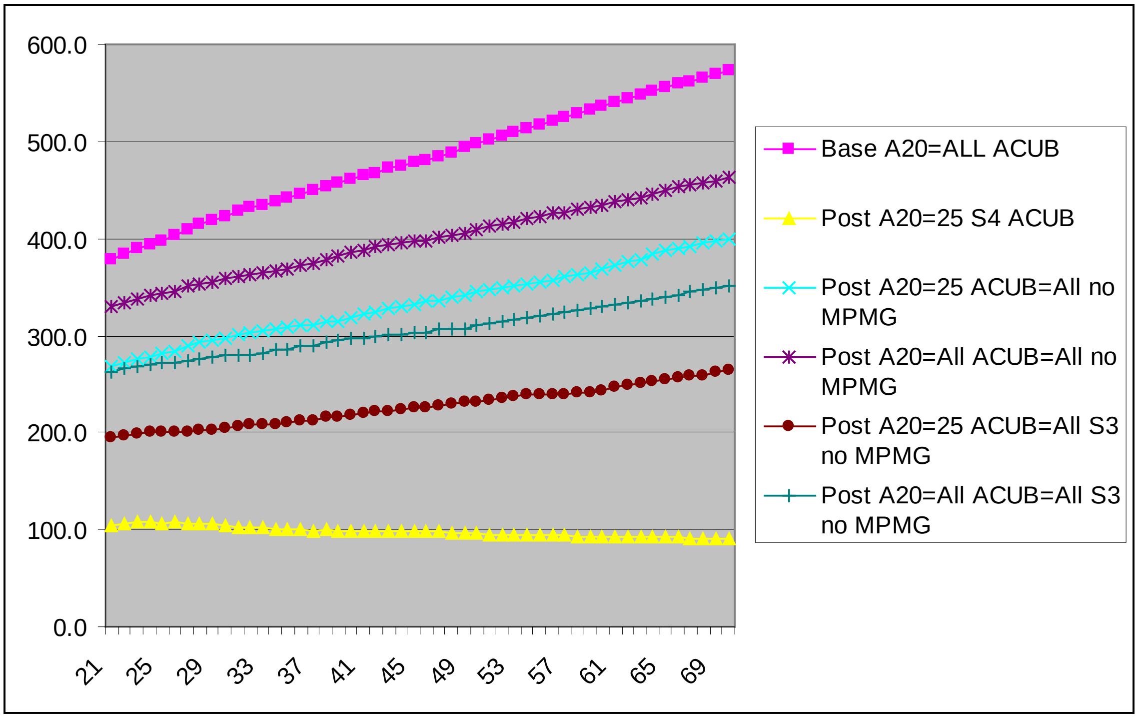

Figure 11. Comparison of baseline and post-MCOE 50-year model simulations (Source: USACE 2009)

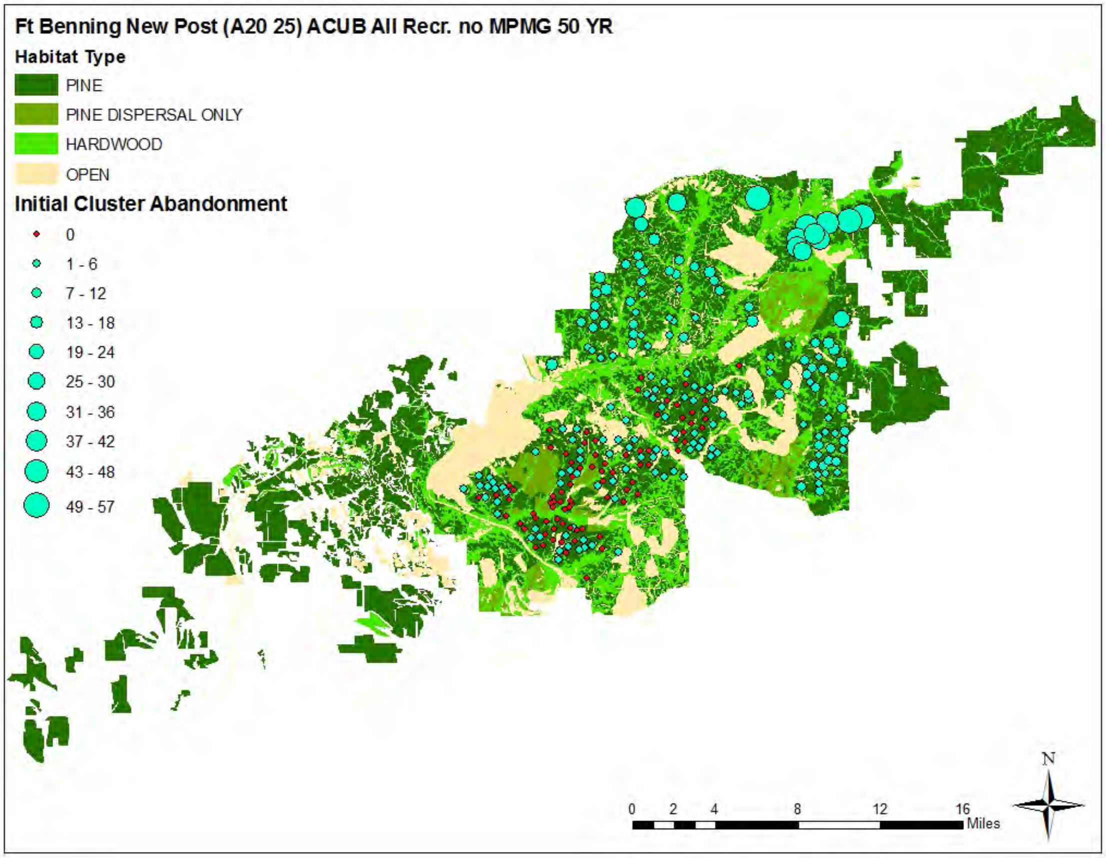

Figure 12. Depiction of RCW cluster vulnerabilities represented as rate of cluster abandonment. Note significant vulnerabilities along eastern boundary.

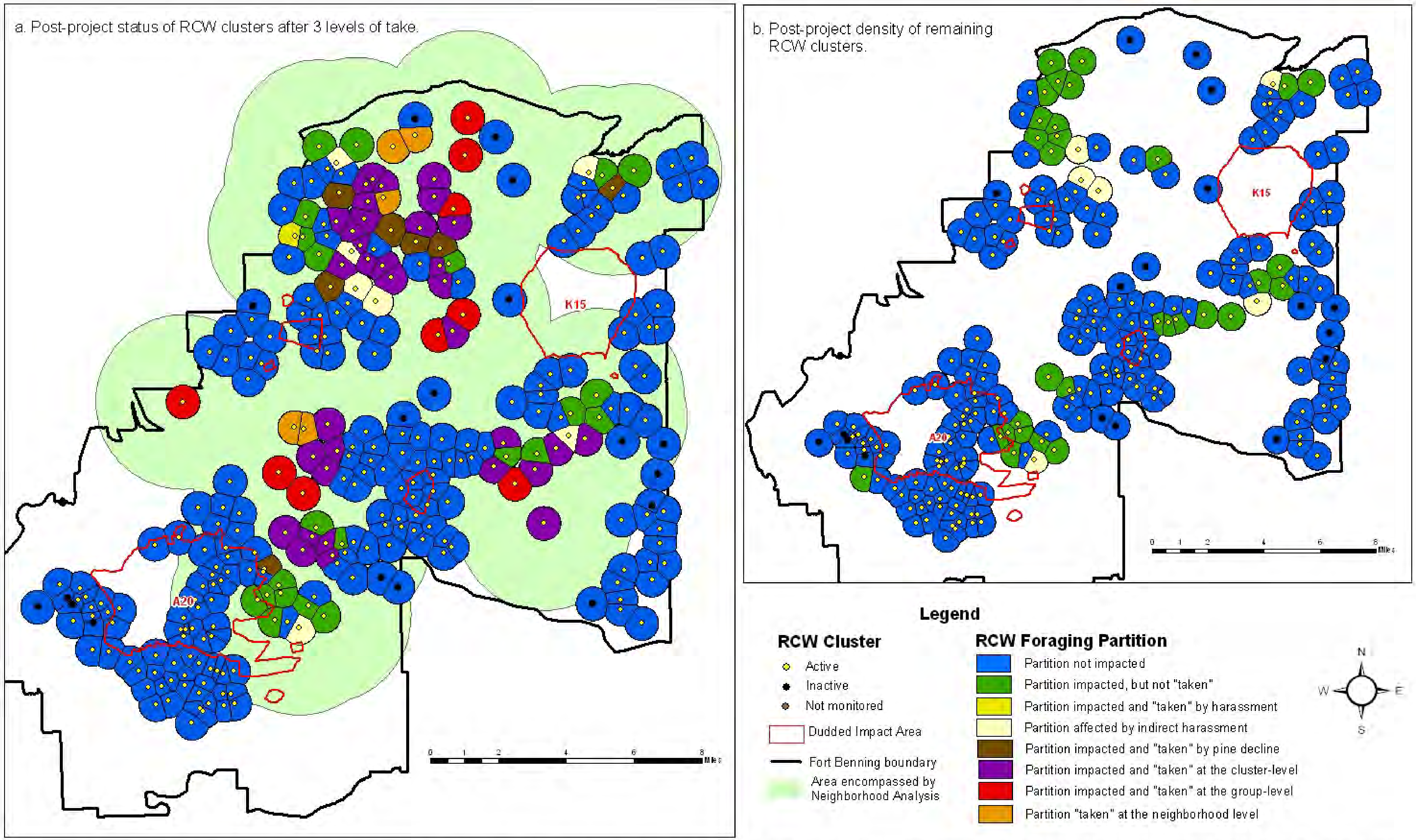

Figure 13. (a.) Post-project status of red-cockaded woodpecker (RCW) clusters after cluster, group (1.25 mile radius) and neighborhood (2.57 radius) analyses and (b.) post-project density of RCW clusters, RPA Analysis, Fort Benning, Georgia.

Appendix B – Tables (*electronic files are separate from biological opinion*)

Table 1. All projects included in the proposed Maneuver Center of Excellence actions including reanalyzed Transformation projects.

Table 2. Selected USAARMS training courses relocating to Ft. Benning.

Table 3 Range-wide RCW status and trend.

Table 4. RCW recovery population trend (active clusters) for the most recent 5-year growth period with data, and average annual percent growth rate (active clusters) for the period.

Table 5. Number of designated recovery populations and declining populations, by active clusters (2007) and 5-year (2002-2007) average annual growth.

Table 6. RCW recovery populations, by population type and rank order size by 2007 active clusters. Sub trend (active clusters) for the most recent 5-year growth period with data, and average annual percent growth rate (active clusters) for the period. Subdivided or separate populations are those in which the configuration and location of the managed area and property or properties results in a subdivided or separate population, which are unlikely to be a demographically-functional single population at recovery.

Table 7. Number of active RCW clusters by size-class and property ownership.

Table 8. Tree mortality estimates from other data sources.

Table 9. Number of 2007 active recovery RCW clusters in recovery populations and properties, from annual RCW report and other data, with estimated number of years from 2007 to attain the recovery population and recovery unit size objectives for potential breeding groups (PBGs) according to three active cluster:PBG ratios. The 1.12:1 active cluster:PBG ratio is the median for all populations computer from 2007 reports.

Table 10. Projections to attain 421 clusters on Fort Benning, from 70-year RCW spatially explicit individual-based population models to 2079 and subsequent forecasts.

Table 11. Simulation scenarios with RCW spatially explicit models, for baseline and post-MCOE conditions with forest decline. Final mean number of RCW clusters are those at the end of the 70-year simulations, with the range (minimum and maximum) in active clusters (AC) produced. The estimated time (Time) and year (Year) with future population growth for attaining the Fort Benning population recovery size objective (421 active clusters) is estimated when the number of active clusters at the end of the 70-year replicated simulation is either the minimum number for which 90% of all simulated end values is equal or greater, or is the minimum number of active clusters for which there is a 0.90 probability of a greater value, given the maximum number from the simulations.

Table 12. Conservation measures included in MCOE biological assessment and addenda (USACE 2008; USDOA 2009a, 2009b).

Table 13. Estimated year of attaining recovery population size objectives, by rank increasing year order, and three active cluster:PBG ratios.

Table 14. Number of active RCW clusters in recovery populations and properties, from annual RCW report and other data, with estimated number of years from 2007 to attain the recovery property, population, and unit size objective, by rank increasing recovery unit year order based on the 1.12:1 (89% PBGs) active cluster:PBG ratio.

Table 15. Projections to attain 421 clusters with the RPA Implemented.

Table 4-24. Reproductive statistics resulting from 50-year runs of various model simulations. Source: U.S. Department of Army, Addendum to the MCOE biological assessment, March 23, 2009.

Table 1. All projects included in the proposed Maneuver Center of Excellence actions at Fort Benning, including reanalyzed Transformation projects.

Project Driver	Project Number	Project Title	Analyzed for Transformation (Y/N)	Fiscal Year- (Start Date)	Fiscal Year- (Date Operational)	Area- Footprint, (Acres)		Area- Limits of Construction (includes		Area- Ordnance or Maneuver-		Maximum Acres of Pine Impacted		Location
						Addendum 1	Addendum 2	Addendum 1	Addendum 2	Addendum 1	Addendum 2	Addendum 1	Addendum 2	
AP3	62953	Rail Loading Facility Expansion	Y	12	----	----	----	133.71	133.71	----	----	28.05	28.05	Harmony Church
BRAC	64460	DS/GS General Maintenance Facility	Y	9	9	----	----	36.39	36.39	----	----	0	0	Harmony Church
BRAC	65322	Shop 1 Maintenance Facility	Y	9	9	----	----	10.37	10.37	----	----	0	0	Harmony Church
BRAC	64797	Tracked Vehicle Drivers Course Access Road	Y	9	10	----	----	18.15	18.15	----	----	9.43	9.43	Harmony Church
BRAC	65034	Fire and Movement Range 3 (FM3)	Y	10	11	10.34	10.34	43.87	43.87	35.86	35.86	50.47	50.47	Oscar Small Arms
BRAC	65035	Basic 10M-25M Firing Range 1 (Z1)	Y	9	11	0.79	0.79	23.01	23.01	3.4	3.4	23.32	23.32	Oscar Small Arms
BRAC	65036	Basic 10M-25M Firing Range 2 (Z2)	Y	9	11	0.79	0	20.9	8.58	27.74	0	28.3	3.18	Oscar Small Arms
BRAC	65039	Basic 10M-25M Firing Range 5 (Z5)	Y	9	11	0.79	0.79	22.02	22.02	0.2	0.2	19.12	19.12	Oscar Small Arms
~~BRAC~~	~~65070~~	~~Multipurpose Machine Gun Range 2 (MPMG2)~~	~~Y~~	~~11~~	~~12~~	~~0~~	~~0~~	~~379.8~~	~~379.8~~	~~719.44~~	~~719.44~~	~~787.62~~	~~787.62~~	~~Southern ranges~~
BRAC	65246	Recreation Centers	Y	12	----	----	----	28.28	28.28	----	----	3.01	3.01	Harmony Church, Sand Hill
BRAC	65248	Physical Fitness Center, Harmony Church	Y	12	----	----	----	38.81	38.81	----	----	0.76	0.76	Harmony Church
BRAC	65383	Stationary Tank Range (ST2)	Y	9	11	0	0	279.74	279.74	1,352.26	1,352.26	527.27	527.27	Northern ranges
BRAC	65554	Construct Training Area Roads Paved	Y	9	11	----	----	715	715	----	----	457.96	457.96	Throughout
BRAC	65557	Repair Existing Training Area Roads, Phase 1	Y	10	----	----	----	361.69	352.44	----	----	209.42	193.67	Throughout
BRAC	69358	Range Access Road - Good Hope Maneuver Training Area	(Y)	9	11	----	----	162.01	162.01	----	----	99.5	99.5	Good Hope
BRAC	69668	Good Hope Training Area Infrastructure	*Y	9	11	----	----	1,523.13	1,523.13	2,589.85	2,589.85	2,092.93	2,092.93	Good Hope
BRAC	69741	19D/K OSUT Training Area Infrastructure	(Y)	9	11	----	----	475.94	270.69	----	----	328.68	180.44	Northern ranges
BRAC	69743	Southern Training Area Infrastructure	*Y	9	11	----	----	577.22	228.33	4,031.08	2,935.64	3,035.86	1,870.93	Northern ranges
BRAC	70235/ 65081/	Hospital Replacement	*Y	**08	----	----	----	137.36	137.36	----	----	2.75	2.75	Main Post
BRAC	72017	Vehicle Recovery Course (Ground Mobility Division)	*Y	9	11	----	----	191.71	191.71	----	----	105.25	105.25	Harmony Church
BRAC	64481	Blood Donor Clinic	N	10	10	----	----	11.6	11.6	----	----	4.87	4.87	Sand Hill
BRAC	64551	Multipurpose Training Range (MPTR)	N	9	----	0	0	1,685.94	1,685.94	0	0	0	0	Northern ranges
BRAC	65033	Fire and Movement Range (FM2)	N	9	11	10.34	10.34	71.43	71.43	32.51	32.51	89.07	89.07	Oscar Small Arms Complex
BRAC	65043	Modified Record Fire Range (MRF 1)	N	9	11	23.72	23.72	46.76	46.76	32.73	32.73	58.88	58.88	Oscar Small Arms
BRAC	65049	Modified Record Fire Range (MRF 7)	N	9	11	23.72	0	48.68	38.08	37.53	2.4	79.53	30.25	Oscar Small Arms
BRAC	65078	Anti-Armor Tracking & Live Fire Complex (LA-AR1)	N	9	----	22.52	22.52	57.31	57.31	6.66	6.66	42.95	42.95	Southern ranges
BRAC	65250	Maneuver Battle Lab	N	10	----	----	----	26.9	26.9	----	----	0	0	Main Post
BRAC	67457	Infrastructure Support, Incr 2. Includes security fence, direct buried cable and road improvement	N	9	----	----	----	246.24	246.24	----	----	54.46	54.46	Northern ranges and Harmony Church

BRAC	Base Realignment and Closure	*Y	Project analyzed under a different PN or no PN in Transformation Biological Assessment
GWOT	Global War on Terror	(Y)	Project combined with other PNs in Transformation Biological Assessment
GTA	Grow the Army	**	Project funded in FY08, however, construction will be ≥ FY 09
GDPR	Global Defense Posture Realignment		Project or value has changed since MCOE Addendum 1
AP3	Army Power Projection Platform	~~PN 65070~~	Project cancelled for RPA

*** Note: overlap between PN's was included in totals to represent the maximum acreage disturbed by each project. Overlap between components of one PN (e.g., overlap between road limits of construction and maneuver space) was eliminated.

Table 1 (cont.). All projects included in the proposed Maneuver Center of Excellence actions at Fort Benning, including reanalyzed Transformation projects.

Project Driver	Project Number	Project Title	Analyzed for Transformation (Y/N)	Fiscal Year- (Start Date)	Fiscal Year- (Date Operational)	Area- Footprint, (Acres)		Area- Limits of Construction (includes range access roads) (Acres)		Area- Ordnance or Maneuver-Impacted Areas (Acres)		Maximum Acres of Pine Impacted		Location
						Addendum 1	Post-design refinement	Addendum 1	Post-design refinement	Pre-design refinement	Addendum 1	Addendum 1	Addendum 1	
GTA	69147	Trainee Complex Upgrade	N	9	----	----	----	81.36	81.36	----	----	4.13	4.13	Sand Hill
GTA	69150	Classrooms & Dual Battalion Dining Facility	N	10	----	----	----	65.74	65.74	----	----	0.6	0.6	Sand Hill
GTA	69151	Dining Facility to Support AST Training	N	10	----	----	----	10.14	10.14	----	----	0	0	Main Post
GDPR	69406	Unit Maintenance Facilities	N	9	----	----	----	50.54	50.54	----	----	1.89	1.89	Main Post
BRAC	69742	Northern Training Area Infrastructure	N	9	11	----	----	255.69	260.12	----	----	198.05	194.88	Northern ranges
GTA	69745/ 72322/ 72324	Training Barracks Complex, Phases 1, 2 and 3	N	10, 11 and 12	----	----	----	130.8	130.8	----	----	71.19	71.19	Sand Hill
GWOT	69999	Warrior in Transition Complex	N	9	----	----	----	46.09	46.09	----	----	0	0	Main Post
GTA	70026/ 72456	Classrooms with Battalion Dining Facilities, Phases 1 and 2	N	10, 11	----	----	----	50.19	50.19	----	----	0	0	Sand Hill
GTA	70027/ 72457	Classrooms with Battalion Dining Facilities, Phases 1 and 2	N	10, 11	----	----	----	72.24	72.24	----	----	4.05	4.05	Sand Hill
BRAC	71065	Troop Store - AAFES (NAF)	N	9	----	----	----	5.64	5.64	----	----	0	0	Harmony Church
BRAC	71473	Water Treatment Plant Upgrade and Expansion	N	10	----	----	----	46.9	46.9	----	----	0	0	Main Post
BRAC	71620	Dental Clinic Addition	N	10	----	----	----	9.99	9.99	----	----	0	0	Main Post
					TOTALS	93.01	68.5	8199.29	7617.41	8869.26	7710.95	8419.37	7012.88	

BRAC	Base Realignment and Closure	*Y	Project analyzed under a different PN or no PN in Transformation Biological Assessment
GWOT	Global War on Terror	(Y)	Project combined with other PNs in Transformation Biological Assessment
GTA	Grow the Army	**	Project funded in FY08, however, construction will be ≥ FY 09
GDPR	Global Defense Posture Realignment		Project or value has changed since MCOE Addendum 1
AP3	Army Power Projection Platform	~~PN 65070~~	Project cancelled for RPA

*** Note: overlap between PN's was included in totals to represent the maximum acreage disturbed by each project. Overlap between components of one PN (e.g., overlap between road limits of construction and maneuver space) was eliminated.

Table 2. Selected USAARMS training courses relocating to Ft. Benning.

Course	Scope	Duration (Days)	Number of Classes/ Year	Total Days/ Year	Vehicle types	Number of Vehicle by Type	Number of personnel (Students, Other)	Percent of Training Conducted at Night	Primary Training Location on Fort Benning
194th Armor Brigade (formerly 1st ATB)									
19 D OUST Calvary Scout	Basic combat training tasks; Army values; physical fitness; first aid; nuclear, biological, and chemical threats; engineer; communications; land navigation; weapons; individual tactical training; intelligence; M# Bradley, Stryker, and HMMWV operation and maintenance	10	23	230	Tracked and wheeled (including Strykers)	40 M2 BFVs, HMMWVs, and Stryker Reconnaissance Vehicles	0	40	19D/K OSUT Maneuver Area, Drivers Training Course, & live fire ranges
19 K OSUT A1A Abrams Armor Crewman	Basic combat training tasks; Army values; physical fitness; first aid; nuclear, biological, and chemical threats; engineer; communications; land navigation; weapons; individual tactical training; M1A series tank and M1025 series HMMWV operation and maintenance	9	13	117	Tracked and wheeled (including Strykers)	55 M1A1 Tanks, HMMWvs, and Stryker Mobile Gun Systems	0	33	19D/K OSUT Maneuver Area, Drivers Training Course, & live fire ranges
63A10 AIT M1A1 Abrams Tank System Maintainer	Test and troubleshoot systems; inspect, service, lubricate, replace and adjust components; use of publications, special tools, test measurement and diagnostic equipment; fundamentals and principals of engine, fuel, exhaust, cooling, and electrical systems; track suspension, steering control, hydraulic systems, engine power train and hull of the M1A1 Abrams tank, perform preventive maintenance checks and services; inspect, service, lubricate, replace, remove, install, adjust, test, purge, and troubleshoot components and control of electrical, mechanical, fire, control components on the M1A1 tank turret	8	17	136	Tracked	10-Live 12- Training Aids	24,12	25	Vehicle Recovery Course
63M10 AIT M2/M3 BFV System Maintainer	Same as above, but for the M2/M3 BFV	8	21	168	Tracked	14- Live 12- Training Aids	40,24	25	Vehicle Recovery Course
ASI H8 Tracked Vehicle Recovery Specialist	Test and troubleshoot systems; inspect, service, lubricate, replace and adjust components; starting, charging, auxiliary power units, brakes, and main winch systems; operating, servicing, and using track recovery vehicles and equipment; procedures used in rigging, recovering and towing of track vehicles	21	16	336	Tracked	4- Live 20- Training Aids	12,6	N/A	Vehicle Recovery Course
U.S. Marine Corps	Similar training to the 19K OSUT, A1A Abrams Armor Crewman, and 63A10 OSUT, M1A1Abrams Tank System Maintainer, but for the Marine Corps	15	9	135	Tracked	4 M88, 2 Mine Plows	18,10	N/A	Vehicle Recovery Course

Source: Final Biological Assessment, Ft. Benning Maneuver Center of Excellence, 27 October 2008.

Table 2 (cont). Selected USAARMS training courses relocating to Ft. Benning.

Course	Scope	Duration (Days)	Number of Classes/ Year	Total Days/ Year	Vehicle types	Number of Vehicle by Type	Number of personnel (Students, Other)	Percent of Training Conducted at Night	Primary Training Location on Fort Benning
16th Calvary Regiment									
Basic Officer Leader Course (BOLC) III	Indoctrination of Army programs and initiatives; military problem solving; risk management; after action review; suicide prevention; combat stress; 9mm pistol qualification; and a two- day field exercise designed to validate pre-commissioning skills, Hands-on equipment oriented instruction is used to train preventive maintenance, checks and services and the M1A1 tanks, tank crew station tasks, and pre-gunnery skills culminating with the tank crew gunnery skills test; property accountability; platoon maintenance operations; and individual and crew nuclear, biological, and chemical operations, Fundamentals of platoon offensive and defensive operations and FTX including force-on-force, free-play, offensive/defensive exercise with opposing forces, conduct troop leading procedures; pre-deployment and deployment operations; and Post- exercise inspections. Also includes tank gunnery, completion training, and Calvary enhancement training.	23	11	253	Tracked and wheeled	23 40	92, 84	50	Good Hope Maneuver Area
2E-F137/521-F2	Indentify and operate within the contemporary operating environment, applying the skills, knowledge and capabilities necessary to ascertain and communicate the nature of the threat with respect to the operating environment to ensure mission success. Involves constructive, virtual, live and computer based training. Includes intelligence preparation of the battlefield and practical exercises to plan and conduct advance reconnaissance and security missions on linear and nonlinear modern day battlefields. Tactical and technical proficiency in all aspects of mounted and dismounted reconnaissance and security operations.	10	11	110	Tracked and wheeled	13 48 (inc. 8 Strykers)	120-160, 95	35	Southern Maneuver Area
Noncommissioned Officer Academy (NCOA)									
19D BNCOC Calvary Scout	In a combat simulated Calvary scout platoon environment: mine warfare; secure communication; tactical movements; demolitions; nuclear, biological and chemical threats; maintenance; safety; troop leading procedures; physical fitness training; training management; tactics; conduct of fire training; BFV gunnery; Field FTX; Common Leader Training; Common Military Training; and tactical seminars in a 2-hour a day NCOA environment.	3	12	36	Tracked and wheeled	12 12	0	20	Southern Maneuver Area; alternate Location is Good Hope
19K BNCOC Armor Crewman	In a combat tactical environment: armor tactics: secure communications; maintenance; tank gunnery; mine warfare; tank weapons; tank crew gunnery test; safety; troop leading procedures; physical fitness training; conduct of fire trainer; STX; and tactical seminars in a 24-hour a day NCOA environment.	3	12	36	Tracked and wheeled	24	0	20	Good Hope Maneuver Area; alternate location is Southern Maneuver Area

Source: Final Biological Assessment, Ft. Benning Maneuver Center of Excellence, 27 October 2008

Table 3. Range-wide RCW status and trend.

Year	Active Clusters	Source
1993	4694	Costa and Walker (1995)
2003	5625	U.S. Fish and Wildlife Service (2003)
2004	5800	Costa and DeLotelle (2006)
2005	5903	U.S. Fish and Wildlife Service (unpubl. data)
2006	6105	U.S. Fish and Wildlife Service (unpubl. data)

Table 4. RCW recovery population trend (active clusters) for the most recent 5-year growth period with data, and average annual percent growth rate (active clusters) for the period.

Recovery Unit / Population / Property	Number of Active Clusters						Average annual percent growth
	2002	2003	2004	2005	2006	2007	
Cumberlands/Ridge & Valley	**9**	**13**	**10**	**0**	**13**	**13**	7.6
Talladega/Shoal Creek Essential Support	9	13	10	0	13	13	7.6
Shoal Creek RD, Talladega NF	9	13	10		13	13	7.6
Talladega RD, Talladega National Forest	0	0		0	0	0	
East Gulf Coastal Plain	**1124**	**1131**	**1116**	**1099**	**1188**	**1254**	2.2
Central FL Panhandle Primary Core	666	663	630	595	656	664	-0.1
Apalachicola RD, Apalachicola NF	484	485	473	475	489	494	0.4
Ochlockonee River State Park	2	2	3	3	2	2	0.0
St. Mark's NWR	10	10	11	11	17	18	12.5
Tate's Hell State Forest	30	32	33		28	20	-7.8
Wakulla RD, Apalachicola National Forest	140	134	110	106	120	130	-1.5
Chickasawhay Primary Core	20	20	20	22	23	31	9.2
Chickasawhay RD, DeSoto NF	20	20	20	22	23	31	9.2
Conecuh/Blackwater Secondary Core	57	54	59	71	77	94	10.5
Blackwater River State Forest	38	32	36	44	49	57	8.4
Conecuh National Forest	19	22	23	27	28	37	14.3
DeSoto Secondary Core	12	14	15	19	18	25	15.8
DeSoto RD, DeSoto National Forest	12	14	15	19	18	25	15.8
Eglin Primary Core	309	313	329	322	346	366	3.4
Eglin Air Force Base	309	313	329	322	346	366	3.4
Homochitto Secondary Core	60	67	63	70	68	74	4.3
Homochitto National Forest	60	67	63	70	68	74	4.3
Mid-Atlantic Coastal Plain	**556**	**572**	**578**		**567**	**583**	**1.0**
Coastal North Carolina Primary Core	173	169	174	179	174	180	0.8
Croatan National Forest	64	60	62	60	59	60	-1.3
Holly Shelter Game Lands	38	37	38	38	36	36	-1.1
Marine Corps Camp Lejeume	71	72	74	81	79	84	3.4
Francis Marion Primary Core	350	361	362		350	363	0.7
Francis Marion National Forest	350	361	362		350	363	0.7
Northeast NC/Southeast VA Essential Support	33	42	42	45	43	40	3.9
Alligator River NWR	2	2	1	1	1		-12.9
Dare County Bombing Range	6	8	6	6	5	5	-3.6
Palmetto-Peartree Preserve	25	26	29	32	31	29	3.0
Pocosin Lakes NWR		6	6	6	6	6	0.0
Ouachita Mountains	**27**	**32**	**36**	**38**	**38**		**8.9**
Ouachita Secondary Core	27	32	36	38	38		8.9
Ouachita National Forest	27	32	36	38	38		8.9

Table 4. Continued.

Recovery Unit / Population / Property	Number of Active Clusters 2002	2003	2004	2005	2006	2007	Average annual percent growth
Piedmont	**54**	**54**	**53**	**55**	**52**	**56**	**0.7**
Oconee-Piedmont Secondary Core	54	54	53	55	52	56	0.7
Oconee National Forest	16	15	14	17	14	18	2.4
Piedmont NWR	38	39	39	38	38	38	0.0
Sandhills	**963**	**982**	**944**	**980**	**1059**	**1094**	**2.6**
Fort Benning Primary Core	243	251	249	254	266	277	2.7
Fort Benning	243	251	249	254	266	277	2.7
North Carolina Sandhills East Primary Core	386	395	405	426	430	446	2.9
Calloway Tract							
Carver's Creek Tract							
Fort Bragg	376	384	396	414	419	436	3.0
McCain Tract	4	5	4	6	6	6	8.4
Weymouth Woods State Nature Preserve	6	6	5	6	5	4	-7.8
North Carolina Sandhills West Essential Spt	151	148	155	161	165	172	2.6
Camp Mackall	12	13	12	14	14	14	3.1
Sandhills Game Lands	139	135	143	147	151	158	2.6
South Carolina Sandhills Secondary Core	183	188	135	139	198	199	1.7
Carolina Sandhills NWR	128	129	135	139	143	144	2.4
Sand Hills State Forest	55	59			55	55	0.0
South Atlantic Coastal Plain	**357**	**428**	**426**	**441**	**469**	**505**	**7.2**
Fort Stewart Primary Core	239	268	271	283	296	316	5.7
Fort Stewart	239	268	271	283	296	316	5.7
Osceola/Okefenokee Primary Core	76	115	110	113	128	141	13.2
Okefenokee NWR	13	38	26	25	37	41	25.8
Osceola National Forest	63	77	84	88	91	100	9.7
Savannah River Secondary Core	42	45	45		45	48	2.7
Savannah River Site	42	45	45		45	48	2.7
South/Central Florida	**292**	**331**	**350**	**371**	**408**	**421**	**7.6**
Avon Park Essential Support	24	25	24	21	25	25	0.8
Avon Park Air Force Range	24	24	24	21	25	25	0.8
Kicco WMA		1					
Babcock/Webb Essential Support	23	24	26	29	29	34	8.1
Babcock Webb WMA	23	24	26	29	29	34	8.1
Big Cypress Essential Support	51	55	57	***57***	***57***	***57***	5.7
Big Cypress National Preserve	51	55	57	*57*	*57*	*57*	5.7

Table 4. Continued.

Recovery Unit / Population / Property	Number of Active Clusters 2002	2003	2004	2005	2006	2007	Average annual percent growth
Camp Blanding Essential Support		16	20	24	26	27	14.0
Camp Blanding Training Site		16	20	24	26	27	14.0
Corbett/Dupuis Essential Support	9	10	13	16	13	15	10.8
J.W. Corbett/Dupuis WMA	9	10	13	16	13	15	10.8
Goethe Essential Support	33	36	37	42	41	44	5.9
Goethe State Forest	33	36	37	42	41	44	5.9
Hal Scott Essential Support	7	6	5	6	8	10	7.4
Hal Scott Preserve	7	6	5	6	8	10	7.4
Ocala Essential Support	29	38	44	54	59	55	13.7
Ocala National Forest	29	38	44	54	59	55	13.7
Picayune Strand Essential Support	7	7	8	7	9	9	6.5
Picayune Strand State Forest	7	7	8	7	9	9	6.5
St. Sebastian River Essential Support	7	7	6	4	6	6	-3.0
St. Sebastian River State Preserve	7	7	6	4	6	6	-3.0
Three Lakes Essential Support	50	51	49	49	47	46	-1.7
Three Lakes WMA	50	51	49	49	47	46	-1.7
Withlacoochee Citrus Essential Support	45	46	47	47	69	73	10.2
Withlacoochee State Forest – Citrus T	45	46	47	47	69	73	10.2
Withlacoochee Croom Essential Support	7	10	14	15	19	20	23.4
Withlacooche State Forest – Croom T	7	10	14	15	19	20	23.4
Upper East Gulf Coastal Plain	**219**	**196**	**194**	**195**	**199**	**207**	**-1.1**
Bienville Primary Core	94	95	94	95	99	105	2.2
Bienville National Forest	94	95	94	95	99	105	2.2
Oakmulgee Secondary Core	125	101	100	100	100	102	-4.0
Oakmulgee RD, Talladega NF	125	101	100	100	100	102	-4.0
Upper West Gulf Coastal Plain	**163**	**152**	**155**	**159**	**170**	**178**	**1.8**
Sam Houston Primary Core	163	152	155	159	170	178	1.8
Sam Houston National Forest	163	152	155	159	170	178	1.8
West Gulf Coastal Plain	**344**	**359**	**362**	**390**	**426**	**442**	**5.1**
Angelina/Sabine Primary Core	59	58	59	63	71	72	4.1
Angelina National Forest	27	29	31	33	37	37	6.5
Sabine National Forest	32	29	28	30	34	35	1.8

Table 4. Continued.

Recovery Unit / Population / Property	Number of Active Clusters 2002	2003	2004	2005	2006	2007	Average annual percent growth
Catahoula Secondary Core	41	48	53	62	75	80	14.3
Catahoula RD, Kisatchie NF	29	35	39	43	53	58	14.9
Winn RD (portion), Kisatchie NF	12	13	14	19	22	22	12.9
Davy Crockett Secondary Core	55	55	58	61	63	65	3.4
Davy Crockett National Forest	55	55	58	61	63	65	3.4
Vernon-Fort Polk Primary Core	189	198	192	204	217	225	3.5
Fort Polk	47	49	47	52	53	55	3.2
Vernon Unit, Calcasieu RD, Kistachie	142	149	145	152	164	170	3.7

Table 5. Number of designated recovery populations and declining populations, by active clusters (2007) and 5-year (2002-2007) average annual growth.

Active Clusters	Number of Populations	Percent	Cumulative Percent	Number Declining
1 – 10	3	8	8	1
11 – 25	5	13	21	0
26 – 50	9	22	43	1
51 – 100	10	25	68	0
101 – 250	7	17	85	1
250 – 350	2	5	90	0
351+	4	10	100	1
Total	40	100	100	4

Table 6. RCW recovery populations, by recovery population type and rank order size by 2007 active clusters. Subdivided or separate populations are those in which the configuration and location of the managed area and property or properties results in a subdivided or separate population, which are unlikely to be a demographically single population at recovery.

Recovery Populations	Active Clusters						Subdivided or Separate Populations
	2002	2003	2004	2005	2006	2007	
Primary Core Populations							
Central FL Panhandle Primary Core	666	663	630	595	656	664	Yes
North Carolina Sandhills East Primary Core	386	395	405	426	430	446	No
Eglin Primary Core	309	313	329	322	346	366	Yes
Francis Marion Primary Core	350	361	362		350	363	TBD
Fort Stewart Primary Core	239	268	271	283	296	316	No
Fort Benning Primary Core	243	251	249	254	266	277	No
Vernon-Fort Polk Primary Core	189	198	192	204	217	225	No
Coastal North Carolina Primary Core	173	169	174	179	174	180	Yes
Sam Houston Primary Core	163	152	155	159	170	178	Yes
Osceola/Okefenokee Primary Core	76	115	110	113	128	141	No
Bienville Primary Core	94	95	94	95	99	105	Yes
Angelina/Sabine Primary Core	59	58	59	63	71	72	Yes
Chickasawhay Primary Core	20	20	20	22	23	31	No
Secondary Core Populations							
South Carolina Sandhills Secondary Core	183	188	135	139	198	199	No
Oakmulgee Secondary Core	125	101	100	100	100	102	Yes
Conecuh/Blackwater Secondary Core	57	54	59	71	77	94	Yes
Catahoula Secondary Core	41	48	53	62	75	80	No
Homochitto Secondary Core	60	67	63	70	68	74	No
Davy Crockett Secondary Core	55	55	58	61	63	65	Yes
Oconee-Piedmont Secondary Core	54	54	53	55	52	56	TBD
Savannah River Secondary Core	42	45	45		45	48	TBD
Ouachita Secondary Core	27	32	36	38	38		TBD
DeSoto Secondary Core	12	14	15	19	18	25	Yes
Essential Support Populations							
North Carolina Sandhills West Essential Spt	151	148	155	161	165	172	Yes
Withlacoochee Citrus Essential Support	45	46	47	47	69	73	TBD
Big Cypress Essential Support	51	55	57	***57***	***57***	***57***	TBD
Ocala Essential Support	29	38	44	54	59	55	TBD
Savannah River Secondary Core	42	45	45		45	48	TBD
Three Lakes Essential Support	50	51	49	49	47	46	TBD
Goethe Essential Support	33	36	37	42	41	44	TBD
Northeast NC/Southeast VA Essential Support	33	42	42	45	43	40	TBD
Babcock/Webb Essential Support	23	24	26	29	29	34	TBD
Camp Blanding Essential Support		16	20	24	26	27	TBD
Avon Park Essential Support	24	25	24	21	25	25	TBD
Withlacoochee Croom Essential Support	7	10	14	15	19	20	TBD
Corbett/Dupuis Essential Support	9	10	13	16	13	15	TBD
Talladega/Shoal Creek Essential Support	9	13	10	0	13	13	No
Hal Scott Essential Support	7	6	5	6	8	10	TBD
Picayune Strand Essential Support	7	7	8	7	9	9	TBD
St. Sebastian River Essential Support	7	7	6	4	6	6	TBD

TBD – To be determined.

Table 7. Number of active RCW clusters from 2007 data, by size-class and property ownership.

Active Clusters	Property Ownership Federal	State	Private	Total	Percent	Cumulative Percent
1 – 10	4	19	17	40	36	36
11 – 25	11	6	8	25	23	59
26 – 50	10	4	3	17	15	74
51 – 100	8	3	3	14	13	87
101 – 250	7	1	0	8	7	94
250 – 350	2	0	0	2	2	96
351+	4	0	0	4	4	100
Total	46	33	31	110	100	100

Table 8: Tree mortality estimates from other data sources

	Loblolly			Shortleaf			Longleaf		
Inches	**4**	10	14	**4**	10	14	**4**	10	14
Forest Inventory	3.3% for all pine trees 10+ dbh								
"Falcon" Field Data	**5.0**	1.8	1.2	**4.5**	3.1	2.3	**1.9**	0.4	0.4
SI-1302 (Sharitz)	**4.7**	2.8	4.3	**2.3**	2.4	1.4	**2.6**	1.1	0.6
SI-1474 (Walker)	**5.5**	2.2	3.9	**3.0**	3.2	0.0	**0.0**	0.0	2.0
Current (S3)	**0.1**	0.1	4.9	**0.1**	0.1	4.1	**0.1**	0.1	0.1
Current (S4)	**4.9**	4.9	4.9	**4.1**	4.1	4.1	**0.1**	0.1	0.1

After removal of CV=3 trees, adjustments of mortality estimates from S3 to those from other studies would yield additional "healthy" forest acres of;
Falcon = 387 acres
SI-1302 = 96 acres
SI-1474 = 344 acres

Note: High mortality in 4 inch diameter class for each species.

Source: USACE 2009

Table 9. Number of 2007 active RCW clusters in recovery populations and properties, from annual RCW report and other data, with estimated number of years from 2007 to attain the recovery population and recovery unit size objectives for potential breeding pairs (PBGs) according to three active cluster:PBG ratios. The 1.12:1 active cluster:PBG ratio (89% PBGs) is the median for all populations computed from 2007 property reports.

Recovery Unit-Population-Property	Active Clusters 2007	Allocated PBG Recovery Goal	Years (1.4:1)	Recovery Size Objective Year	Years (1.25:1)	Recovery Size Objective Year	Years (1.12:1)	Recovery Size Objective Year
Cumberlands/Ridge & Valley	**14**	**100**	**53**	**2060**	**53**	**2060**	**50**	**2057**
Talladega/Shoal Creek Essential Support	14	100	53	2060	53	2060	50	2057
Shoal Creek RD, Talladega NF	13	53	23	2030	21	2028	20	2027
Talladega RD, Talladega NF	1	47	53	2060	53	2060	50	2057
East Gulf Coastal Plain	**1254**	**2450**	**87**	**2094**	**82**	**2089**	**78**	**2085**
Central FL Panhandle Primary Core	664	1000	81	2088	76	2083	71	2078
Apalachicola RD, Apalachicola NF	494	338	0	2007	0	2007	0	2007
Ochlockonee River State Park	2	2	4	2011	3	2010	1	2008
St. Mark's NWR	18	48	17	2024	16	2023	14	2021
Tate's Hell State Forest	20	270	81	2088	76	2083	71	2078
Wakulla RD, Apalachicola NF	130	342	58	2065	55	2062	48	2055
Chickasawhay Primary Core	31	350	87	2094	82	2089	78	2085
Chickasawhay RD, DeSoto NF	31	350	87	2094	82	2089	78	2085
Conecuh/Blackwater Secondary Core	94	250	64	2071	59	2066	54	2061
Blackwater River SF	57	32	0	2007	0	2007	0	2007
Conecuh NF	37	218	64	2071	59	2066	54	2061
DeSoto Secondary Core	25	250	75	2082	70	2077	65	2072
DeSoto RD, DeSoto NF	25	250	75	2082	70	2077	65	2072
Eglin Primary Core	366	350	13	2020	10	2017	3	2010
Eglin AFB	366	350	13	2020	10	2017	3	2010
Homochitto Secondary Core	74	250	60	2067	55	2062	51	2058
Homochitto NF	74	250	60	2067	55	2062	51	2058
Mid-Atlantic Coastal Plain	**584**	**800**	**44**	**2051**	**37**	**2044**	**34**	**2041**
Coastal North Carolina Primary Core	180	350	44	2051	37	2044	33	2040
Croatan National Forest	60	156	44	2051	37	2044	33	2040
Holly Shelter Game Lands	36	35	9	2016	7	2014	6	2013
Marine Corps Camp Lejeune	84	159	38	2045	33	2040	28	2035
Francis Marion Primary Core	363	350	13	2020	10	2017	4	2011
Francis Marion National Forest	363	350	13	2020	10	2017	4	2011
Northeast NC/Southeast VA Essential Support	41	100	37	2044	36	2043	34	2041
Alligator River National Wildlife Refuge	1	14	37	2044	36	2043	34	2041
Dare County Bombing Range	5	33	28	2035	27	2034	25	2032
Palmetto-Peartree Preserve	29	18	0	2007	0	2007	0	2007
Pocosin Lakes National Wildlife Refuge	6	35	27	2034	25	2032	24	2031
Ouachita Mountains	**38**	**250**	**70**	**2077**	**65**	**2072**	**60**	**2067**
Ouachita Secondary Core	38	250	70	2077	65	2072	60	2067
Ouachita National Forest	38	250	70	2077	65	2072	60	2067
Piedmont	**56**	**250**	**60**	**2067**	**55**	**2062**	**50**	**2057**
Oconee-Piedmont Secondary Core	56	250	60	2067	55	2062	50	2057
Oconee National Forest	18	162	60	2067	55	2062	50	2057
Piedmont National Wildlife Refuge	38	88	23	2030	15	2022	13	2020
Sandhills	**1088**	**1050**	**26**	**2033**	**22**	**2029**	**17**	**2024**
Fort Benning Primary Core	277	350	26	2033	22	2029	16	2023
Fort Benning	277	350	26	2033	22	2029	16	2023
North Carolina Sandhills East Primary Core	440	350	9	2016	8	2015	7	2014
Fort Bragg	436	344	4	2011	0	2007	0	2007
Weymouth Woods State Nature Preserve	4	6	9	2016	8	2015	7	2014
North Carolina Sandhills West Essential Support	172	100	0	2007	0	2007	0	2007
Camp Mackall	14	6	0	2007	0	2007	0	2007
Sandhills Game Lands	158	94	0	2007	0	2007	0	2007
South Carolina Sandhills Secondary Core	199	250	26	2033	21	2028	17	2024
Carolina Sandhills National Wildlife Refuge	144	144	15	2022	12	2019	5	2012
Sand Hills State Forest	55	106	26	2033	21	2028	17	2024

Table 9. Continued.

Recovery Unit-Population-Property	Active Clusters 2007	Allocated PBG Recovery Goal	Years (1.4:1)	Recovery Size Objective Year	Years (1.25:1)	Recovery Size Objective Year	Years (1.12:1)	Recovery Size Objective Year
South Atlantic Coastal Plain	**505**	**950**	**67**	**2074**	**62**	**2069**	**57**	**2064**
Fort Stewart Primary Core	316	350	20	2027	17	2024	10	2017
Fort Stewart	316	350	20	2027	17	2024	10	2017
Osceola/Okefenokee Primary Core	141	350	63	2070			54	2061
Okefenokee National Wildlife Refuge	41	55	9	2016	7	2014	6	2013
Osceola National Forest	100	295	63	2070	60	2067	54	2061
Savannah River Secondary Core	48	250	67	2074	62	2069	57	2064
Savannah River Site	48	250	67	2074	62	2069	57	2064
South/Central Florida	**421**	**440**	**22**	**2029**	**21**	**2028**	**19**	**2026**
Avon Park Essential Support	25	40	10	2017	9	2016	7	2014
Avon Park Air Force Range	25	39	10	2017	9	2016	7	2014
Babcock/Webb Essential Support	34	40	7	2014	5	2012	4	2011
Babcock/Webb Wildlife Management Area	34	40	7	2014	5	2012	4	2011
Big Cypress Essential Support	57	40	0	2007	0	2007	0	2007
Big Cypress National Preserve	57	40	0	2007	0	2007	0	2007
Camp Blanding Essential Support	27	25	3	2010	2	2009	1	2008
Camp Blanding Training Site	27	25	3	2010	2	2009	1	2008
Corbett/Dupuis Essential Support	15	40	15	2022	15	2022	14	2021
J.W. Corbett/Dupuis WMA	15	40	15	2022	15	2022	14	2021
Goethe Essential Support	44	40	3	2010	2	2009	0	2007
Goethe State Forest	44	40	3	2010	2	2009	0	2007
Hal Scott Essential Support	10	15	9	2016	8	2015	7	2014
Hal Scott Preserve	10	15	9	2016	8	2015	7	2014
Ocala Essential Support	55	40	0	2007	0	2007	0	2007
Ocala National Forest	55	40	0	2007	0	2007	0	2007
Picayune Strand Essential Support	9	25	17	2024	16	2023	14	2021
Picayune Strand State Forest	9	25	17	2024	16	2023	14	2021
St. Sebastian River Essential Support	6	25	22	2029	21	2028	19	2026
St. Sebastian River State Buffer Preserve	6	25	22	2029	21	2028	19	2026
Three Lakes Essential Support	46	40	1	2008	1	2008	0	2007
Three Lakes Wildlife Management Area	46	40	1	2008	1	2008	0	2007
Withlacoochee Citrus Tract Essential Support	73	40	0	2007	0	2007	0	2007
Withlachoochee State Forest - Citrus Tract	73	40	0	2007	0	2007	0	2007
Withlacoochee Croom Tract Essential Support	20	30	9	2016	8	2015	7	2014
Withlacoochee State Forest - Croom Tract	20	30	9	2016	8	2015	7	2014
Upper East Gulf Coastal Plain	**207**	**600**	**69**	**2076**	**66**	**2073**	**59**	**2066**
Bienville Primary Core	105	350	69	2076	66	2073	59	2066
Bienville National Forest	105	350	69	2076	66	2073	59	2066
Oakmulgee Secondary Core	102	250	55	2062	52	2059	45	2052
Oakmulgee Ranger District, Talladega NF	102	250	55	2062	52	2059	45	2052
Upper West Gulf Coastal Plain	**178**	**350**	**45**	**2052**	**42**	**2049**	**35**	**2042**
Sam Houston Primary Core	178	350	45	2052	42	2049	35	2042
Sam Houston National Forest	178	350	45	2052	42	2049	35	2042
West Gulf Coastal Plain	**442**	**1200**	**56**	**2063**	**50**	**2057**	**46**	**2053**
Angelina/Sabine Primary Core	72	350	56	2063	50	2057	46	2053
Angelina National Forest	37	172	53	2060	48	2055	43	2050
Sabine National Forest	35	178	56	2063	50	2057	46	2053
Catahoula Secondary Core	80	250	41	2048	36	2043	31	2038
Catahoula Ranger District, Kisatchie NF	58	137	37	2044	32	2039	27	2034
Winn Ranger District (portion), Kisatchie NF	22	113	41	2048	36	2043	31	2038
Davy Crockett Secondary Core	65	250	62	2069	57	2064	52	2059
Davy Crockett National Forest	65	250	62	2069	57	2064	52	2059
Vernon-Fort Polk Primary Core	225	350	35	2042	30	2037	26	2033
Fort Polk	55	130	35	2042	30	2037	26	2033
Vernon Unit, Calcasieu RD, Kisatchie NF	170	220	27	2034	24	2031	17	2024

Table 10. Projections to attain 421 clusters on Fort Benning, from 70-year RCW spatially explicit individual-based population models to 2079 and subsequent forecasts. Note: growth estimates begin in the year 2009.

Simulation	Initial Clusters	Final Mean Clusters	Model Cluster Growth Rate	Average Annual Percent Growth	Solitary Males	PBGs	%PBGs	Years to 421 @ Model Rate	421 Year @ Model Rate	Years to 421 Clusters @ 2.5%	421 Year @ 2.5% Rate	Years to 421 Clusters@ 5%	421 Year @ 5.0% Rate
50 Base A20 =25 No Rec	321	460	0.0072	0.72	17.7	443	96.2			15	2024	7	2016
50 Base A20 =25 Rec	321	525	0.0099	0.99	22.8	502	95.7			20	2029	10	2019
50 Base A20=25 ACUB	314	480	0.0085	0.85	19.9	461	95.9			17	2026	9	2018
50 Base A20=25 ACUB S3	215	325[1]	0.0099	0.99	17.8	335	95.0	50	2129	77	2086	74	2083
50 Base A20=25 ACUB S4	200	312	0.0089	0.89	15.6	296	95.0			82	2091	79	2088
50 Post A20=25	223	351	0.0091	0.91	17.5	333	95.0	50	2129	77	2086	74	2083
50 Post A20=25 S3	154	198[1]	0.0081	0.81	14.3	216	93.8	50	2129	101	2110	85	2094
50 Post A20=25 S4	101	93	-0.0016	-0.16	8.9	84	90.4			131	2140	101	2110
50 Post A20=25 ACUB=All	264	362	0.0063	0.63	18.7	343	94.8	50	2129	76	2085	73	2082
50 Post A20=25 ACUB=All S3	183	226	0.0042	0.42	13.8	212	93.9	50	2129	95	2104	83	2092
50 Post A20=25 ACUB=All S4	101	86	-0.0032	-0.32	8.8	77	89.8			134	2143	113	2112
50 Post A20=25 ACUB=All no MPMG	262	401	0.0085	0.85	17.7	383	95.6	50	2129	72	2081	71	2080
50 Base A20=All ACUB	366	573	0.0090	0.90	22.3	550	96.1			18	2027	9	2018
50 Base A20=All ACUB S3	219	363	0.0102	1.02	16.8	346	95.4	50	2129	76	2085	73	2082
50 Base A20=25 S3	215	347	0.0096	0.96	16.6	330	95.2	50	2129	78	2087	74	2083
50 Base A20=All ACUB=All	366	581	0.0093	0.93	24.7	557	95.7			19	2028	9	2018
50 Base A20=All ACUB=All S3	219	355	0.0097	0.97	17.6	338	95.0	50	2129	77	2086	73	2082
50 Post A20=25 ACUB	223	337	0.0083	0.83	17.0	320	95.0	50	2129	79	2088	75	2084
50 Post A20=25 ACUB S3	155	193	0.0043	0.43	13.5	179	93.0	50	2129	102	2111	86	2095
50 Post A20=25 ACUB S4	101	91	-0.0011	-0.11	9.2	86	90.4			130	2139	100	2109
50 Post A20=All ACUB	280	433	0.0087	0.87	17.4	415	96.0			18	2027	9	2018
50 Post A20=All ACUB=All	389	497	0.0049	0.49	22.2	475	95.5			10	2019	5	2014
50 Post A20=All ACUB=All no MPMG	325	455	0.0067	0.67	21.0	434	95.4			14	2023	7	2016
50 Post A20=All ACUB=All S3	231	300	0.0053	0.53	16.7	284	94.4	50	2129	14	2093	7	2086
50 Post A20=All ACUB=All S3 no MPMG	258	351	0.0060	0.60	18.4	330	94.7	50	2129	8	2087	4	2083
50 Post A20=25 ACUB=All no MPMG	262	400	0.0085	0.85	23.4	377	94.2	50	2129	2	2081	1	2080
50 Post A20=25 ACUB=All S3 no MPMG	191	264	0.0065	0.65	15.7	248	94.1	50	2129	19	2098	10	2089

1 – Values in this table differ from those of Table 4-24, Final Addendum to the Final Biological Assessment for Proposed Maneuver Center of Excellence at Fort Benning, GA. Values listed in this table were generated and computed from the raw simulation output spreadsheet data provided by Ft. Benning to the Service.

Table 11. Simulation scenarios with RCW spatially explicit models, for baseline and post-MCOE conditions with forest decline. Final mean number of RCW clusters are those at the end of the 70-year simulations, with the range (minimum and maximum) in active clusters (AC) produced. The estimated time (Time) and year (Year) with future population growth for attaining the Fort Benning population recovery size objective (421 active clusters) is estimated when the number of active clusters at the end of the 70-year replicated simulation is either the minimum number for which 90% of all simulated end values is equal or greater, or is the minimum number of active clusters for which there is a 0.90 probability of a greater value, given the maximum number from the simulations.

Simulation	Final Mean Clusters	Std. Dev.	AC Range		90% Min. Value			0.90 Probability Min. Value		
			Min	Max	ACs	Time	Year	ACs	Time	Year
50 Base A20=25 S3	347.9	40.9	191	404	296	14	2093	294	15	2094
50 Base A20=25 ACUB S3	324.8	43.7	190	393	256	20	2099	269	18	2097
50 Base A20=All ACUB S3	363.2	39.0	216	411	322	11	2090	313	12	2091
50 Base A20=All ACUB=All S3	355.1	49.1	149	434	303	13	2092	292	15	2094
50 Post A20=25 S3	197.5	52.5	60	274	133	47	2126	130	48	2127
50 Post A20=25 ACUB S3	192.5	42.4	59	265	136	46	2125	138	45	2124
50 Post A20=25 ACUB=All S3	226.1	36.1	106	278	183	34	2113	180	34	2113
50 Post A20=All ACUB=All S3	300.3	34.2	196	359	253	21	2100	256	20	2099
50 Post A20=All ACUB=All S3 no MPMG	351.3	38.3	244	420	308	13	2092	302	13	2092
50 Base A20=25 ACUB S4	311.8	43.4	92	374	268	18	2097	256	20	2099
50 Post A20-25 ACUB S4	91.4	34.7	18	166	45	91	2170	47	89	2168
50 Post A20=25 ACUB=All S4	86.0	36.4	13	168	41	95	2174	39	97	2176

Table 12. Conservation measures included in MCOE biological assessment and addenda (USACE 2008; USDOA 2009a, 2009b)

Proposed MCOE conservation efforts	Comments
1. NEPA review process	1. see Term and Condition
2. Environmental awareness program	2. see Term and Condition
3. Ongoing research regarding pine and RCW management	3. PI - J. Walker (USFS,) underway, converting off-site loblolly. PI – L. Eckhardt (Auburn U.), concluding, LLP decline. PI – J. Walker (USFS), 2009, local & regional pine decline issues. PI – C. Rewerts, ongoing, RCW dynamics model. PI – S. Ustin (UC Davis), underway, hyperspectral imagery for detection of pine decline.
4. Use DMPRC data to inform construction and use of MCOE ranges	4. Monitoring results will be in the Habitat Monitoring Report due July 2009.
5. History of fire on Ft. Benning	5. Ft. Benning has received this report and will use the results to guide longleaf restoration on the Installation.
6. Evaluating training effects on RCWs	6. PI - T. Hayden (ERDC), design underway, evaluation of BRAC/MCOE activities on Installation RCWs; expected completion date 2013; see Term and Condition
7. Activities to occur pre & post timbering activities.	7. Protocols include measures to minimize impacts to wetlands and other sensitive areas, harvest reports and RCW survey requirements
8. Total land management strategy.	8. A carryover from the BRAC BO, the strategy will focus on soil conservation and sustainable ranges. The Strategy is due for completion November 2009.
9. Access plan	9. The current access plan will be updated to accommodate the additional training needs of MCOE and provide continued access to accomplish all RCW management (e.g., burning, land management, banding, etc).
10. Co-use and subdivision of training compartments	10. Current training compartments will be sub-divided to better accommodate the increased land use requirements, including all RCW requirements.
11. Cantonment area projects, ranges and roads	11. As the design of project components becomes final, minimization of impacts to relict trillium, RCWs and their habitat will be incorporated.
12. Management of active clusters where cavity trees will be removed	12. All cavities will be screen to stop RCW use at the time of the cutting. Translocation of groups will be in coordination with the Service.
13. Management of active clusters adversely affected by loss of foraging habitat	13. The Army plans to continue managing these groups with the intent of eventually counting the groups, upon Service approval, towards the Installation population recovery objective.
14. Improvement of stands to avoid adverse effects	14. Ft. Benning will improve stands (e.g., suppress hardwood midstory, thin overstory hardwoods) to avoid adverse impacts in 17 clusters.
15. Demographic monitoring at affected RCW clusters	15. The demographic monitoring plan completed for the BRAC projects will be expanded to include those RCW clusters affected by the MCOE projects.
16. Habitat monitoring at affected RCW clusters	16. Habitat monitoring will enable detection of impacts to vegetation as a result of project construction and operation. The Habitat Impact Assessment Plan will be completed in July 2009. See Term and Condition.
17. Compliance Monitoring	17. Compliance monitoring includes the Army and groups contracted to work on MCOE related activities. See Term and Condition.

Table 12. Continued.

Proposed MCOE conservation efforts	Comments
18. Berming of small arms ranges	18. Berming can significantly reduce impacts to RCW habitat associated with ranges. See Term and Condition.
19. Remote monitoring using unmanned aircraft.	19. Development of remote monitoring may eventually enable more frequent monitoring of RCW groups.
20. Dudded impact areas	20. As stated in the MCOE RPA, 36 clusters will be assessed to meet the requirements of RCW monitoring and management in the A20 impact area. The Installation intends to gain ground access to 11 additional active clusters in FY09 and 11 more active clusters in FY10 as progress towards full management of the 36 additional clusters.
21. Habitat conservation outside the Installation.	21.The ACUB program will be accelerated to buffer the Installation and protect and restore habitat for listed and other at-risk species, including management of pine uplands to provide RCW habitat. An off-post habitat conservation plan will be completed within one year after formal consultation (May 2010.)

Table 13. Estimated year of attaining recovery population size objectives, by rank increasing year order, and three active cluster:PBG ratios.

Recovery Population	Active Clusters 2007	PBG Recovery Goal	Years (1.4:1)	Recovery Size Objective Year	Years (1.25:1)	Recovery Size Objective Year	Years (1.12:1)	Recovery Size Objective Year
Big Cypress Essential Support	57	40	0	2007	0	2007	0	2007
North Carolina Sandhills West Essential Support	172	100	0	2007	0	2007	0	2007
Withlacoochee Citrus Tract Essential Support	73	40	0	2007	0	2007	0	2007
Ocala Essential Support	55	40	0	2007	0	2007	0	2007
Three Lakes Essential Support	46	40	1	2008	1	2008	0	2007
Goethe Essential Support	44	40	3	2010	2	2009	0	2007
Camp Blanding Essential Support	27	25	3	2010	2	2009	1	2008
Eglin Primary Core	366	350	13	2020	10	2017	3	2010
Francis Marion Primary Core	363	350	13	2020	10	2017	4	2011
Babcock/Webb Essential Support	34	40	7	2014	5	2012	4	2011
North Carolina Sandhills East Primary Core	446	350	9	2016	8	2015	7	2014
Hal Scott Essential Support	10	15	9	2016	8	2015	7	2014
Withlacoochee Croom Tract Essential Support	20	30	9	2016	8	2015	7	2014
Avon Park Essential Support	26	40	10	2017	9	2016	7	2014
Fort Stewart Primary Core	316	350	20	2027	17	2024	10	2017
Corbett/Dupuis Essential Support	15	40	15	2022	15	2022	14	2021
Picayune Strand Essential Support	9	25	17	2024	16	2023	14	2021
Fort Benning Primary Core	277	350	26	2033	22	2029	16	2023
South Carolina Sandhills Secondary Core	199	250	26	2033	21	2028	17	2024
St. Sebastian River Essential Support	6	25	22	2029	21	2028	19	2026
Vernon-Fort Polk Primary Core	225	350	35	2042	30	2037	26	2033
Catahoula Secondary Core	80	250	41	2048	36	2043	31	2038
Coastal North Carolina Primary Core	180	350	44	2051	37	2044	33	2040
Northeast NC/Southeast VA Essential Support	41	100	37	2044	36	2043	34	2041
Sam Houston Primary Core	178	350	45	2052	42	2049	35	2042
Oakmulgee Secondary Core	102	250	55	2062	52	2059	45	2052
Angelina/Sabine Primary Core	72	350	56	2063	50	2057	46	2053
Oconee-Piedmont Secondary Core	56	250	60	2067	55	2062	50	2057
Talladega/Shoal Creek Essential Support	14	100	53	2060	53	2060	50	2057
Homochitto Secondary Core	74	250	60	2067	55	2062	51	2058
Davy Crockett Secondary Core	65	250	62	2069	57	2064	52	2059
Osceola/Okefenokee Primary Core	141	350	63	2070	60	2067	54	2061
Conecuh/Blackwater Secondary Core	94	250	64	2071	59	2066	54	2061
Savannah River Secondary Core	48	250	67	2074	62	2069	57	2064
Bienville Primary Core	105	350	69	2076	66	2073	59	2066
Ouachita Secondary Core	38	250	70	2077	65	2072	60	2067
DeSoto Secondary Core	25	250	75	2082	70	2077	65	2072
Central FL Panhandle Primary Core	664	1000	81	2088	76	2083	71	2078
Chickasawhay Primary Core	31	350	87	2094	82	2089	78	2085

Table 14. Number of active RCW clusters in recovery populations and properties, from annual RCW report and other data, with estimated number of years from 2007 to attain the recovery property, population, and unit size objective, by rank increasing recovery unit year order based on the 1.12:1 (89% PBGs) active cluster:PBG ratio.

Recovery Unit-Population-Property	Active Clusters 2007	Allocated PBG Recovery Goal	Years (1.4:1)	Recovery Size Objective Year	Years (1.25:1)	Recovery Size Objective Year	Years (1.12:1)	Recovery Size Objective Year
Sandhills	**1088**	**1050**	**26**	**2033**	**22**	**2029**	**17**	**2024**
Fort Benning Primary Core	277	350	26	2033	22	2029	16	2023
Fort Benning	277	350	26	2033	22	2029	16	2023
North Carolina Sandhills East Primary Core	440	350	9	2016	8	2015	7	2014
Fort Bragg	436	344	4	2011	0	2007	0	2007
Weymouth Woods State Nature Preserve	4	6	9	2016	8	2015	7	2014
North Carolina Sandhills West Essential Support	172	100	0	2007	0	2007	0	2007
Camp Mackall	14	6	0	2007	0	2007	0	2007
Sandhills Game Lands	158	94	0	2007	0	2007	0	2007
South Carolina Sandhills Secondary Core	199	250	26	2033	21	2028	17	2024
Carolina Sandhills National Wildlife Refuge	144	144	15	2022	12	2019	5	2012
Sand Hills State Forest	55	106	26	2033	21	2028	17	2024
South/Central Florida	**421**	**440**	**22**	**2029**	**21**	**2028**	**19**	**2026**
Avon Park Essential Support	25	40	10	2017	9	2016	7	2014
Avon Park Air Force Range	25	39	10	2017	9	2016	7	2014
Babcock/Webb Essential Support	34	40	7	2014	5	2012	4	2011
Babcock/Webb Wildlife Management Area	34	40	7	2014	5	2012	4	2011
Big Cypress Essential Support	57	40	0	2007	0	2007	0	2007
Big Cypress National Preserve	57	40	0	2007	0	2007	0	2007
Camp Blanding Essential Support	27	25	3	2010	2	2009	1	2008
Camp Blanding Training Site	27	25	3	2010	2	2009	1	2008
Corbett/Dupuis Essential Support	15	40	15	2022	15	2022	14	2021
J.W. Corbett/Dupuis WMA	15	40	15	2022	15	2022	14	2021
Goethe Essential Support	44	40	3	2010	2	2009	0	2007
Goethe State Forest	44	40	3	2010	2	2009	0	2007
Hal Scott Essential Support	10	15	9	2016	8	2015	7	2014
Hal Scott Preserve	10	15	9	2016	8	2015	7	2014
Ocala Essential Support	55	40	0	2007	0	2007	0	2007
Ocala National Forest	55	40	0	2007	0	2007	0	2007
Picayune Strand Essential Support	9	25	17	2024	16	2023	14	2021
Picayune Strand State Forest	9	25	17	2024	16	2023	14	2021
St. Sebastian River Essential Support	6	25	22	2029	21	2028	19	2026
St. Sebastian River State Buffer Preserve	6	25	22	2029	21	2028	19	2026
Three Lakes Essential Support	46	40	1	2008	1	2008	0	2007
Three Lakes Wildlife Management Area	46	40	1	2008	1	2008	0	2007
Withlacoochee Citrus Tract Essential Support	73	40	0	2007	0	2007	0	2007
Withlachoochee State Forest - Citrus Tract	73	40	0	2007	0	2007	0	2007
Withlacoochee Croom Tract Essential Support	20	30	9	2016	8	2015	7	2014
Withlacoochee State Forest - Croom Tract	20	30	9	2016	8	2015	7	2014
Mid-Atlantic Coastal Plain	**584**	**800**	**44**	**2051**	**37**	**2044**	**34**	**2041**
Coastal North Carolina Primary Core	180	350	44	2051	37	2044	33	2040
Croatan National Forest	60	156	44	2051	37	2044	33	2040
Holly Shelter Game Lands	36	35	9	2016	7	2014	6	2013
Marine Corps Camp Lejeune	84	159	38	2045	33	2040	28	2035
Francis Marion Primary Core	363	350	13	2020	10	2017	4	2011
Francis Marion National Forest	363	350	13	2020	10	2017	4	2011
Northeast NC/Southeast VA Essential Support	41	100	37	2044	36	2043	34	2041
Alligator River National Wildlife Refuge	1	14	37	2044	36	2043	34	2041
Dare County Bombing Range	5	33	28	2035	27	2034	25	2032
Palmetto-Peartree Preserve	29	18	0	2007	0	2007	0	2007
Pocosin Lakes National Wildlife Refuge	6	35	27	2034	25	2032	24	2031

Table 14. Continued.

Recovery Unit-Population-Property	Active Clusters 2007	Allocated PBG Recovery Goal	Years (1.4:1)	Recovery Size Objective Year	Years (1.25:1)	Recovery Size Objective Year	Years (1.12:1)	Recovery Size Objective Year
Upper West Gulf Coastal Plain	**178**	**350**	**45**	**2052**	**42**	**2049**	**35**	**2042**
Sam Houston Primary Core	178	350	45	2052	42	2049	35	2042
Sam Houston National Forest	178	350	45	2052	42	2049	35	2042
West Gulf Coastal Plain	**442**	**1200**	**56**	**2063**	**50**	**2057**	**46**	**2053**
Angelina/Sabine Primary Core	72	350	56	2063	50	2057	46	2053
Angelina National Forest	37	172	53	2060	48	2055	43	2050
Sabine National Forest	35	178	56	2063	50	2057	46	2053
Catahoula Secondary Core	80	250	41	2048	36	2043	31	2038
Catahoula Ranger District, Kisatchie NF	58	137	37	2044	32	2039	27	2034
Winn Ranger District (portion), Kisatchie NF	22	113	41	2048	36	2043	31	2038
Davy Crockett Secondary Core	65	250	62	2069	57	2064	52	2059
Davy Crockett National Forest	65	250	62	2069	57	2064	52	2059
Vernon-Fort Polk Primary Core	225	350	35	2042	30	2037	26	2033
Fort Polk	55	130	35	2042	30	2037	26	2033
Vernon Unit, Calcasieu RD, Kisatchie NF	170	220	27	2034	24	2031	17	2024
Cumberlands/Ridge & Valley	**14**	**100**	**53**	**2060**	**53**	**2060**	**50**	**2057**
Talladega/Shoal Creek Essential Support	14	100	53	2060	53	2060	50	2057
Shoal Creek RD, Talladega NF	13	53	23	2030	21	2028	20	2027
Talladega RD, Talladega NF	1	47	53	2060	53	2060	50	2057
Piedmont	**56**	**250**	**60**	**2067**	**55**	**2062**	**50**	**2057**
Oconee-Piedmont Secondary Core	56	250	60	2067	55	2062	50	2057
Oconee National Forest	18	162	60	2067	55	2062	50	2057
Piedmont National Wildlife Refuge	38	88	23	2030	15	2022	13	2020
South Atlantic Coastal Plain	**505**	**950**	**67**	**2074**	**62**	**2069**	**57**	**2064**
Fort Stewart Primary Core	316	350	20	2027	17	2024	10	2017
Fort Stewart	316	350	20	2027	17	2024	10	2017
Osceola/Okefenokee Primary Core	141	350	63	2070			54	2061
Okefenokee National Wildlife Refuge	41	55	9	2016	7	2014	6	2013
Osceola National Forest	100	295	63	2070	60	2067	54	2061
Savannah River Secondary Core	48	250	67	2074	62	2069	57	2064
Savannah River Site	48	250	67	2074	62	2069	57	2064
Upper East Gulf Coastal Plain	**207**	**600**	**69**	**2076**	**66**	**2073**	**59**	**2066**
Bienville Primary Core	105	350	69	2076	66	2073	59	2066
Bienville National Forest	105	350	69	2076	66	2073	59	2066
Oakmulgee Secondary Core	102	250	55	2062	52	2059	45	2052
Oakmulgee Ranger District, Talladega NF	102	250	55	2062	52	2059	45	2052
Ouachita Mountains	**38**	**250**	**70**	**2077**	**65**	**2072**	**60**	**2067**
Ouachita Secondary Core	38	250	70	2077	65	2072	60	2067
Ouachita National Forest	38	250	70	2077	65	2072	60	2067
East Gulf Coastal Plain	**1254**	**2450**	**87**	**2094**	**82**	**2089**	**78**	**2085**
Central FL Panhandle Primary Core	664	1000	81	2088	76	2083	71	2078
Apalachicola RD, Apalachicola NF	494	338	0	2007	0	2007	0	2007
Ochlockonee River State Park	2	2	4	2011	3	2010	1	2008
St. Mark's NWR	18	48	17	2024	16	2023	14	2021
Tate's Hell State Forest	20	270	81	2088	76	2083	71	2078
Wakulla RD, Apalachicola NF	130	342	58	2065	55	2062	48	2055
Chickasawhay Primary Core	31	350	87	2094	82	2089	78	2085
Chickasawhay RD, DeSoto NF	31	350	87	2094	82	2089	78	2085
Conecuh/Blackwater Secondary Core	94	250	64	2071	59	2066	54	2061
Blackwater River SF	57	32	0	2007	0	2007	0	2007
Conecuh NF	37	218	64	2071	59	2066	54	2061
DeSoto Secondary Core	25	250	75	2082	70	2077	65	2072
DeSoto RD, DeSoto NF	25	250	75	2082	70	2077	65	2072
Eglin Primary Core	366	350	13	2020	10	2017	3	2010
Eglin AFB	366	350	13	2020	10	2017	3	2010
Homochitto Secondary Core	74	250	60	2067	55	2062	51	2058
Homochitto NF	74	250	60	2067	55	2062	51	2058

Table 15. Projections to attain 421 clusters with the RPA implemented.

Simulation	Active clusters starting from yr. 2029	Years to 421 clusters @ 2.5% growth starting from yr. 2029	Active clusters starting from yr. 2079	Years to 421 clusters @ 2.5% growth starting from yr. 2079
S4 Baseline (A20=36)	211	2055	323	2087
S4 MCOE (A20=36)	112	2080	102	2134
S4 Baseline (A20=25)	200	2057	312	2089
S4 MCOE (A20=25)	101	2084	91	2139

Note: Projections use 2009 data, assumes no ACUB influence and assumes all suitable habitat is contiguous.

Table 4-24. Reproductive statistics resulting from 50-year runs of various model simulations.

Simulation	Initial Groups	Occupied Groups	Occ. SD	Population growth	Group Size	% Initial Cluster Abandon	Solitary Males	% Rec Cluster Occ
Base A20 =25 No Recruitment	321	460	27	1.010	2.87	2.9	17.7	0.0
Base A20 =25 Recruitment	321	525	33	1.012	2.81	4.4	22.8	88.4
Base A20=25 ACUB	321	480	31	1.011	2.86	3.8	19.9	90.7
Base A20=25 ACUB S3	215	353	45	1.012	2.76	9.7	17.8	79.2
Base A20=25 ACUB S4	200	312	43	1.010	2.76	10.2	15.6	70.2
Post A20=25 ACUB	223	351	50	1.011	2.81	13.6	17.5	78.7
Post A20=25 ACUB S3	154	230	47	1.009	2.69	20.1	14.3	52.2
Post A20=25 ACUB S4	101	93	43	0.997	2.64	45.2	8.9	43.6
Post A20=25 ACUB=All	264	362	38	1.009	2.87	7.0	18.7	73.8
Post A20=25 ACUB=All no MPMG	262	401	35	1.011	2.88	7.4	17.7	69.7
Post A20=25 ACUB=All S3	183	226	36	1.006	2.79	15.7	13.8	66.6
Post A20=25 ACUB=All S3 no MPMG	191	264	48	1.008	2.75	14.9	15.7	58.2
Post A20=25 ACUB=All S4	101	86	36	0.996	2.68	46.8	8.8	36.2
Base A20=All ACUB=All	386	581	33	1.012	2.88	3.6	24.7	78.0
Base A20=All ACUB=All S3	239	355	49	1.011	2.73	10.8	17.6	67.3
Post A20=All ACUB=All	319	447	28	1.008	2.92	2.9	22.2	61.1
Post A20=All ACUB=All no MPMG	325	455	46	1.009	2.84	6.6	21.0	66.8
Post A20=All ACUB=All S3	231	300	34	1.007	2.83	9.9	16.7	46.1
Post A20=All ACUB=All S3 no MPMG	258	349	28	1.008	2.80	8.9	18.4	59.7

Initial	initial number of groups in the 50-year runs.
Occupied	average number of occupied clusters after 70 years.
Occ. SD	standard deviation of occupied clusters.
Population growth	population growth rate.
Group Size	average number of adult birds per group after 70 years (initial value=2.4).
%Initial Cluster Abandon	percentage of initial clusters abandoned.
Solitary Males	average number of solitary bird clusters after 70 years.
% Rec. Cluster Occ.	percentage of occupied recruitment clusters after 70 years.

Base	Baseline, includes Transformation projects not reanalyzed for MCOE
Post	Post-MCOE (and Transformation)
A20=25	Includes 25 manageable clusters in A20 Impact Area
A20=All	Includes all clusters in A20
ACUB	Includes ACUB short-term (fee simple)
ACUB=All	Includes all ACUB lands: short-term and long-term
S3, S4	Simulation included forest health Simulation 3 or 4
MPMG, no MPMG	With or without the proposed MCOE MultiPurpose Machine Gun range

Source: U.S. Department of Army, Addendum to the MCOE biological assessment, March 23, 2009,.

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APPENDIX C: Methods to Estimate Future Time and Year of Attaining Recovery Population and Unit Size Objectives

Introduction

Recovery criteria in the 2003 RCW recovery plan (U.S. Fish and Wildlife Service, 2003) was formulated on the basis of 11 recovery units, each with a designated number of primary core, secondary core, and essential support populations on specific properties managed by designated agencies (Table 1). There are 13 primary core populations each with at an objective of least 350 potential breeding groups (PBGs), 10 secondary core populations each with 250 PBGs, and 17 essential support populations with from 15 to 100 PBGs.

The recovery plan includes an estimate of the future time to for each designated recovery population to attain the size required for delisting (Recovery Plan Table 14). The future projection was based on several assumptions:

- Habitat is not a limiting factor, with trees of a sufficient age and size for good quality foraging habitat and natural cavities, without dependence on artificial cavities;
- All populations grow at the minimum recommended plan rate of 5 percent average annual growth of active clusters or potential breeding groups (PBGs); and
- The ratio of active clusters to PBGs is 1.4:1.

The Recovery Plan procedure computed the total number of active clusters in 2000 from all properties representing designated primary core, secondary core, and essential support recovery populations, and projected forward at an average annual 5% annual growth.

The Recovery Plan does not specify an objective for the future time of recovery. Given the Recovery Plan objective of an average annual population growth of 5 to 10 percent, the future time for recovery is an inherent consequence and objective. The future time of recovery is important because it reflects the size and growth of populations at different intervals. RCW population size is a critical factor affecting the ability of a population to withstand adverse effects of inbreeding and demographic, environmental, genetic, and catastrophic stochasticity. Adverse effects of reduced population growth rates and prolonging recovery will depend on the particular population affected, as well as the status and vulnerability of other populations. This is because RCW recovery ultimately depends on the establishment of populations in recovery units throughout most of the historic range of the species. This geographic arrangement not only reduces range wide impacts from catastrophic recurring hurricanes, but is intended to facilitate sufficient immigration and emigration among populations to avoid adverse effects of genetic drift.

The purpose of this Appendix is to describe the methods and procedures for generating a modified and updated estimate of the future time of attaining recovery population and unit size objectives.

Methods and Procedure

The procedure to estimate future population growth, size, and time to achieving the designated recovery population size follows the same basic methods used in the recovery plan, although with modifications. It is a deterministic demographic projection, based on the extent designated recovery populations consist of multiple properties, an initial size of the recovery population or recovery property-population, the active cluster:PBG ratio (%PBGs), and an average annual percent growth rate, as described in the following sections.

<u>Initial Population Size and the Recovery Population/Property-Population Size Objective</u>

The 39 designated recovery populations consist of at least 62 different properties (Biological Opinion Table 9). A property is a distinct parcel owned and managed by a federal, state, or other agency or organization. A single property comprises 24 (61.5%) of the 39 recovery populations. The remaining 15 populations consist of multiple properties.

Each population is designated as a primary core, secondary core, or essential support population with a recovery population size PBG objective. Where multiple properties comprise a recovery population, a specific population size objective was not allocated to each property in the 2003 Recovery Plan. There is inherent flexibility in attaining recovery population size objectives where there are multiple properties because, in most cases, the combined RCW management goals among the managing agencies for the properties exceed the designated recovery population objective. For example, the Conecuh-Blackwater River secondary core population, with an objective of 250 PBGs, consists of 2 properties, the Conecuh National Forest and Blackwater River State Forest. The RCW management objectives developed by each agency exceed the minimum total required for this secondary core recovery population.

Estimates of time to reach the recovery population size in the 2003 Recovery Plan for populations with multiple properties were predicted on the basis that RCWs on the properties functioned as a single demographic population. For any population with multiple properties, the initial population size from 2000 data was estimated as the total number of active clusters from all respective properties. This population was then projected forward in time at a 0.05 annual average geometric growth rate, with a 1.4:1 active cluster to PBG ratio.

Adding all active clusters and PBGs from the properties comprising a recovery population to estimate the initial population size for a future growth and time projection is not appropriate if RCWs on the individual properties comprise more than one demographic population. Separate populations, even with the same annual growth rate, have different trajectories to the time required to reach the property goal. The actual time to reach the "population" goal becomes the time for the individual property with the longest interval required to reach its goal.

The Recovery Plan (p. 150) recognized at least 4 recovery populations, each with multiple recovery properties that may function as relatively isolated subpopulations at recovery: the Angelina/Sabine Primary Core, Coastal North Carolina Primary Core, Osceola/Okefenokee Primary Core, and Northeast North Carolina/Southeast Virginia Essential Support. In addition, there is evidence the Central Florida Panhandle Primary Core and North Carolina Sandhills West Essential Support populations with multiple properties are subdivided (Biological Opinion Table 6). These are questionable single populations at recovery population size objectives because of the location and distances of the properties from each other, relative to average RCW dispersal distances to replace breeding vacancies in nearby groups.

If the Coastal North Carolina Primary Core population is a single population, then it is estimated to achieve the population size objective (350 PBGs) in 36 years from the year 2007 (Appendix C Figure 1). This estimate is based on the total active clusters (180) from its 3 constituent properties, at 1.25:1 active clusters to PBG ratio (0.80 PBGs/active cluster), and a 0.025 average annual geometric growth rate to 350 PBGs. If the 3 properties are separate populations, the time to a recovery "population" of 350 PBGs is about 48 years. This is because the Croatan National Forest, with 48 PBGs in 2007, required the greatest period (48 years) to attain its property goal for recovery, while the Holly Shelter Game Lands objective was attained in 8 years, and the Marine Corps Camp Lejeune in 35 years (Appendix C Figure 1).

Any designated recovery population with demographically separate property-populations will require a greater period of time to reach the recovery size objective than a single population with the same number of active clusters or PBGs. The additional time required depends on the size of the initial property-populations and the recovery population size objective, all other factors equal.

The potential for RCW demographic isolation and subdivision within designated recovery populations is not solely a response to the spatial distribution of multiple properties. It also depends on the spatial distribution and aggregation of RCW groups over time within and among properties. A recovery population, regardless of the number of recovery-properties, can be functionally subdivided as separate populations when RCW groups are spatially isolated. As the number of groups increase in geographic locations with initially separate populations, then geographic isolation and subdivision can diminish with population growth and expansion, eventually with the establishment of a demographically functional, single population.

The extent that recovery populations with single or multiple properties adequately function or fail to function as single populations is a source of error to predictions of the future time to the recovery population size. The best available information is insufficient to assess actual RCW population structure at this time on many recovery populations and properties. This requires spatial data on the location of current RCW groups as well as future recruitment clusters and foraging partitions at recovery population size objectives.

In the absence of such data, population growth projections for the future time of recovery with multiple properties were made on the basis of growth in each property-population. The time to reach the recovery "population" size objective was the time when a sufficient number of PBGs collectively were attained from all constituent properties.

This approach requires subdividing the population size recovery objective to each respective property-population, which was not allocated as such in the Recovery Plan. This allocation was based on the RCW "property goal" (e.g. Recovery Plan Table 18) for each property, or from other updated management plan data. The property goal is the managing agency's goal for the number of active RCW clusters. In the absence of an agency goal or management plan, the Recovery Plan estimated the potential number of active clusters from information on the amount of potential habitat, divided by 200 acres for each cluster. Active cluster property goals for most populations with multiple properties exceed the total number of active clusters required for recovery.

To partition a recovery population objective among constituent properties, the total number of active clusters from the property goals was computed from all constituent properties. Then, the proportion of the total property goal active clusters was calculated for each property. The total number of recovery PBGs for the population was multiplied by the proportion for each property to generate an allocated portion of the recovery objective for each property. For example, a population recovery objective of 250 PBGs with 2 properties, one with a property goal of 200 active clusters and the other with 85 active clusters, would be partitioned as 175 PBGs for one property (200/285 x 250) and 75 PBGs (85/285 x 250) for the other.

The initial size of each population or property-population was the number of active clusters reported by each managing agency, from the Service's Annual RCW Report and Translocation Database.

<u>Active cluster to PBG ratios</u>

Recovery population size objectives are based on the number of PBGs. RCW population size estimates and monitoring protocols involve two measures; active clusters and PBGs. An active cluster is an occupied territory by one or more RCWs. An active cluster can consist of either breeding pair or single-male. Most active clusters consist of PBGs. Estimates of population size based on number of active clusters require converting the number of active clusters, based on estimates of the proportion of active clusters that are PBGs.

Forecasts in the 2003 Recovery Plan of the time to reach recovery population size objectives were based on a 1.4:1 active cluster to PBG ratio, equivalent to 71.4% of active clusters occupied by PBGs. The proportion of active clusters occupied by PBGs is not constant. It can vary within a population over time, as well as among populations. The active cluster to PBG ratio used in a population model to forecast future growth can affect the time estimated to achieve the recovery population size objective. The greater the proportion of active clusters occupied by PBGs, the less time required to achieve population recovery objectives. The Recovery Plan future time forecast was conservative, using a low value for the proportion of active clusters with PBGs. As such, the Recovery Plan forecast tended not to underestimate time to recovery based on active cluster:PBG ratios.

To assess the ratio in this updated and modified future estimate, the range of the proportion of PBGs in active clusters from recent data was calculated and evaluated in relation to population size. The Annual RCW Report and Translocation Database included sufficient 2007 data to compute the proportion of PBGs in active clusters from 37 properties managed for RCWs. The percentage PBGs in active clusters ranged from 70.6 to 100. Thirty-one of these 37 properties are RCW recovery properties. The 6 properties not designated with recovery populations are affirmatively managed for RCWs. Percent PBGs on the non-recovery properties ranged from 70.6 to 100.0 during 2007.

Percent PBGs were not normally distributed for all properties. Standard data transformations did not successfully normalize the data (Appendix C Table 2). The mean and median percent PBGs from these property populations were closely related. The range for the mean and median percent PBGs, depending on the data and transformation, were, respectively, 89.5 – 91.9 and

89.2 – 89.3 (Table 5). The 71.4% PBG value used in the recovery plan forecast clearly was a very conservative value.

No relationship was evident between the percent PBGs and property population size (active clusters) based on nonparametric statistical methods and a generalized linear model (GLM). Percent PBGs did not increase or decrease with population size (Spearman rank order correlation r = 0.1069, p = 0.1069). Also, population size class (1-50, 51-100, 100+) did not affect percent PBGs (Figure 4, Kruskal-Wallis ANOVA by ranks, H = 0.4746, p = 0.7889). The Kruskal-Wallis ANOVA did not include a 1-25 population active cluster size class because of the limited number of observations (n = 2). Results of a generalized linear model (GLM) found no effect of population size on percent PBGs (Appendix C Table 3). In contrast to linear models, GLMs do not require the response variable (%PBGs) to be normally distributed, which in this case are non-normal, and relaxes the equality of variances requirement.

The sensitivity of population projections to the proportion of active clusters with PBGs was examined by deterministic growth simulations of initial hypothetical populations at 4 sizes (25, 50, 75, and 100 active clusters), each with 7 active cluster:PBG ratios (1.43:1, 1.33:1, 1.25:1, 1.18:1, 1.11:1, and 1.00:1), and solving for the time (years) to reach a primary core recovery population of 350 PBGs and a secondary core recovery population with 250 PBGs, with a 0.05 and 0.025 average annual geometric growth rate (Appendix C Tables 4 and 5). Active cluster:PBG ratios and their corresponding proportion of active clusters with PBGs were 1.43:1 – 0.70, 1.33:1 – 0.75, 1.25:1 – 0.80, 1.18:1 – 0.85, 1.11:1 – 0.90, 1.05:1 – 0.95, and 1:1 – 1.00.

For any initial population with any active cluster:PBG ratio, populations with 0.025 annual growth rates required twice as long to reach the recovery population size objective as those with 0.05 growth rates – as expected. Effects were much less for active cluster:PBG ratios on the time to reach the recovery population size objective. Populations with 1:1 active cluster:PBG ratios (1 PBG per active cluster) reduced the time required to reach 350 PBGs by about 7 years, relative to populations with 1.4 active clusters:PBG (0.70 PBGs per active cluster) for any initial population size at 0.05 growth rates (Appendix C Table 4). At the lower 0.025 average geometric growth rate for the same parameters, the time to reach 350 PBGs was reduced by about 15 years (Appendix C Table 5). For a secondary core population of 250 PBGs, the same reduction in time is evident as affected by active cluster:PBG ratios (Table 8).

For example, an initial population of 25 active clusters at a 0.025 annual geometric growth required 121 years to reach 350 PBGs, with a 1.4 active cluster:PBG ration (0.70 PBGs/active clusters). The same initial population, but with 1 active cluster: PBG (1 PBG/active cluster) attained the size objective in 107 years. The greater proportion of PBGs in active clusters reduced the recovery time by 15 years. At a greater 0.05 average geometric growth rate, the initial population with 0.70 PBGs/active clusters required 62 years for recovery, compared to 55 years with 1 PBG/active cluster, a difference of 7 years.

The absolute difference in number of years to recovery affected by populations with 0.70 active clusters/PBG relative to 1 active cluster/PBG is constant. However, the percentage of the time to recovery is variable, depending on years to recovery. As the initial population size increases, the number of years to recovery decreases, and the percentage of years to recovery reduced by a greater proportion of PBGs (PBGs/active clusters) increases (Appendix C Tables 4 and 5). A 15-year reduction to a 50-year time to recovery is a greater percentage than a 15-year reduction to a 100-year recovery time. For example, an initial population of 100 active clusters, 1.4 active clusters:PBGs (0.7 PBGs/active cluster), and 0.025 annual growth rate reached 250 PBGs in 52 years. The same population with 1 PBG/active cluster required 37 years for recovery, a 28 percent reduction in the recovery time period.

These data indicate the absolute future time (years) to recovery is not highly sensitive to the range of active cluster:PBG ratios from 1.4:1 to 1.0:1, although a very high proportion of PBGs/active clusters can reduce the future period by 30 percent or more for larger initial populations. Smaller initial populations are more sensitive to active cluster:PBG ratios than larger populations. Given these factors, the median value for the active cluster:PBG ratio (1.12:1, 89% PBGs) was selected to update the recovery time forecast.

Population growth rates

The projected future time of reaching the objective population size depends on the population model and rate of growth. The recovery plan forecast did not specify the actual model, but the objective of recovery task 1.2 to "[p]rovide and maintain a sufficient number of recruitment clusters to achieve an annual average rate of population increase between 5 and 10 percent" clearly is indicative of a geometric growth model. The "model" is the mathematical relationship between the current population size and its future size, as affected by growth. Geometric population growth is a discrete-time, density-independent model. It is discrete because the rates of growth are applied at distinct time (e.g. annual) intervals, in this case in response to the annual nesting and reproduction that occurs, usually, once each year. It is density-independent because the rate of population growth is constant and does not change in response to an increasing or decreasing population size. It is deterministic because there is only one solution for the estimated future population size at a future designated time.

Geometric growth is analogous to a compound rate, where the rate applies to the population size at each discrete annual time interval. Growth is the rate that new RCW active clusters or PBGs are annually produced and added to the population. The geometric rate, r, is;

$$r = \sqrt[t]{Pf / Pi} - 1 \text{ , or } \log(1+r) = \frac{\log(Pf / Pi)}{t}$$

where Pf is the final RCW population size, Pi is the initial population size, and t is the number of years of growth. Given r, the time interval required to reach a final population of size Pf from an initial population, Pi, is:

$$t = \frac{\log(Pf / Pi)}{\log(1+r)}$$

Given a time period r for population growth, the size of the population at the end of the period (number of years) is:

$$Pf = Pi(1+r)^t$$

For example, a RCW population of 100 PBGs at year 0, with an average annual geometric growth rate of 0.05 (5%), would consist of 105 PBGs in year 1. In year 2, the rate applies to the incremental period population of 105 PBGs – not 100 PBGs, and so forth. This is in contrast to arithmetic growth, in which the growth rate applies to the initial population size at each incremental period.

Geometric and exponential growth generally are not considered widely applicable models of natural populations of many species because large populations will be predicted to increase nonlinearly, reaching very large sizes quickly without limitation. Natural conditions eventually will limit the size and growth of most populations. However, RCW population forecasts with a geometric growth model are reasonable forecasts under RCW conservation and recovery management because limiting factors to population growth should be ameliorated. RCW recovery depends on inducing the formation of new groups at recruitment clusters with artificial cavities, where needed, to temporarily compensate for the natural cavity limitations to population growth. As trees age and become suitable for natural cavities at established clusters, the reliance on maintaining artificial cavities diminishes and eventually becomes unnecessary. The recovery plan objective and recommendation is to annually provide a number of recruitment clusters equal to 10% of the active clusters in the population. Thus, effective recovery management providing recruitment clusters with habitat restoration and maintenance should eliminate limiting factors to population growth toward the recovery population size objective.

RCW population growth rates naturally vary from year to year. Although the net growth is positive in well managed populations, rates vary mostly in response to demographic and environmental factors. The growth and time forecasts used in the Recovery Plan and by the geometric projections in this Biological Opinion do not incorporate the effects of stochastic demographic and environmental variation on the growth. This variation affects male and female survival, nesting, reproductive success, and recruitment of offspring in the population. These effects have been incorporated in RCW spatially explicit individual-based (SEPM) models that simulate RCW group and population dynamics, but the SEPM programs and other spatial data required are not available to make such population projections for all designated recovery populations. The effects of stochastic variation and annually variable growth rates in a population model would produce variation in the number of RCW PBGs or active clusters for any given future year. This variation, in turn, would generate estimates of different population sizes at any give future year, for which there would be an average based on replications of the model simulations. Without such data and models, the projections in the Recovery Plan and in this Biological Opinion generally represent average conditions relative to the respective geometric growth rates used.

The recovery objective is to increase the number of PBGs or active clusters in populations at a 5 – 10% average annual growth rate. Projections in the 2003 Recovery Plan based on 5% represent the lowermost range of this objective. This assumes that all populations are being successfully managed at recovery levels. If not, then future forecasts will not be realistic and other growth rates should be considered. To assess the applicability of other geometric growth rates, recent 5-year growth rates from recovery populations were computed and compared to the recovery objective of a minimum 5% average annual growth. The relationship of observed growth rate to population size was statistically assessed by parametric and non-parametric methods. Conditions contributing to low or negative growth rates were assessed to identify populations that were not likely to represent growth rates of reasonably well managed or representative populations. Based on these factors, average annual geometric growth rates other than 5% were selected as the basis of future forecasts, in combination with other variables described in this Appendix.

Observed 5-year growth rates

Population size data from all designated recovery properties were extracted from the Annual RCW Report and Translocation Database or other data for the 2002 – 2007 period, representing 5 years of growth, to assess the status of recent actual recovery population growth. The average annual geometric growth was calculated for this period.

Of the 39 designated recovery populations, 18 (46%) had an average annual RCW population growth equal to or greater than 5% during the past 5 years (Biological Opinion Table 4). The overall average annual percent growth in most recovery populations was less than the recovery objective. Recovery population growth rates ranged from -3.9 to 23.4%, with a mean of 5.8% and median of 4.1%. Most populations overall were either stable or increasing at some rate. Four recovery populations (Three Lakes Essential Support, Central Florida Panhandle Primary Core, St. Sebastian River Essential Support, and the Oakmulgee Secondary Core) declined.

Future population estimates based on an average annual rate of 5% represent the minimal ideal recovery condition that is not actually representative of recent performance. Future population forecasts based on 5% are not realistic, at least in the short term.

The 39 designated recovery populations are managed on a total of at least 62 properties, for which 58 reported sufficient data to estimate growth during this period (Biological Opinion Table 4). A number of factors likely are affecting growth in designated recovery populations, but these are difficult to ascertain without reference to the actual growth in each managed property for the 14 recovery populations that consist of multiple properties. The average annual geometric growth rate estimated for these 14 recovery populations is an overall rate, depending on the actual performance and management of the constituent properties. Even when constituent properties comprise a single demographic recovery population, differences in recovery and habitat management by the respective can significantly affect growth. Among all recovery properties, 10 (17%) had negative growth rates during this period, from -1.1 to -7.8%. Most (83%) properties were either stable or had positive growth. Only 23 (40%) of all recovery properties had growth rates of 5% or greater. The mean growth for all properties was 4.7% (Shapiro-Wilk $W = 0.9681$, $p = 0.1231$), median 3.3%, with a range from -12.9 to 25.8%.

Several factors appear to be affecting properties with negative growth rates and rates below the recovery growth objective. Recovery management at some of these properties is deficient at one or more levels, probably involving habitat restoration, maintenance, and the provision of sufficient recruitment clusters. These include Croatan National Forest, Alligator River NWR, and Oakmulgee Ranger District-Talladega National Forest. Properties such as Sam Houston National Forest and Bienville National Forest until just recently had declining populations, with growth only during the last couple of years.

Natural factors are likely limiting the response of other properties where effective recovery management probably has minimized recent negative or low growth rates. For example, St. Sebastian River State Buffer Preserve and Three Lakes WMA may have been affected by recent drought and hurricanes appear to be limiting the population response to positive management. Management on the Wakulla Ranger District-Apalachicola National Forest, with a slight population decline, has provided sufficient recruitment clusters for population growth, but cavity competition by other birds in habitat with low quality ground cover appears to be a limiting factor (Chuck Hess, U.S. Forest Service, pers. comm.). These or other naturally occurring factors, while limiting, are expected to be temporary.

All properties with the largest populations had positive growth, but most are less than 5%, including Eglin Air Force Base (3.4%), Fort Bragg (3.0%), Fort Benning (2.7%), Francis Marion National Forest (0.7%), and Apalachicola Ranger District-Apalachicola National Forest (0.4%). All of these properties have active RCW conservation programs, particularly on DoD installations. The Apalachicola RD, with 494 active clusters in 2007, is the largest single property population, but managers no longer extensively use recruitment clusters because the property has reached its management goal. Recruitment clusters are used at the other large populations, but the precise factors contributing to less than 5% growth would require other assessments.

There are 32 properties with the smallest number of RCWs, less than 46 active clusters and mostly less than 30 PBGs, which includes those with the greatest (25.8%) and lowest (-7.8%) rates of growth among all properties. Of these 32 properties, 20 (63%) have been active participants in RCW translocation programs to augment or grow the population as quickly as possible to at least 30 PBGs or, if less, the property management goal. RCW translocation programs are important elements of recovery management, to boost and stabilize demographically and environmentally vulnerable small populations.

The factors affecting growth on properties and recovery populations are diverse, including natural annual variation and the effects of recovery management programs. However, a general trend is evident between the 5-year growth rates and property population size (Appendix C Figure 2). Growth rates and variation in rates of the largest populations, with more than 100 active clusters, tend to be less than those of smaller populations. Populations with 50 or fewer active clusters include those with the greatest variation and range of growth of growth rates.

Projecting future population growth for each property and recovery population on the basis of an average annual rate of 5% is a prediction assuming consistent recovery management without any natural limiting factors. A continuation of recent 5-year growth trends would not represent recovery-level management for all designated populations or attainment of recovery population sizes predicted on the basis of a minimum average annual 5% growth rate. Recovery Plan population growth rate objectives are important, but it is unrealistic to expect all properties or populations to grow at recovery-level objectives. Yet, forecasting future growth for each property population future based solely on its past 5-year trends is unrealistic as well.

Many small populations with high growth rates are benefiting from intensive management, particularly RCW translocation to augment populations and increase growth. These growth rates will not continue indefinitely. RCW translocation objectives typically are to augment the population until 30 PBGs are attained, after which continued growth depends on group induction of resident RCWs at recruitment clusters. Conversely, the lower growth rates of the largest property-populations are not representative of the smaller, actively managed populations with larger rates. Of the 6 largest property-populations with more than 250 active clusters in 2007, only Ft. Stewart with 5.7% growth exceeded the minimum 5% recovery growth objective. Recent trends indicate it is unrealistic to expect all the large populations to annually grow at 5% or greater rates. Small populations, whether increasing or decreasing, also differ from large populations because a small change in the number of active clusters or PBGs produces a large change in the annual percent growth rates.

Declining property-populations, regardless of their size, will not indefinitely decline because they are expected to become subject to increased management to resolve limiting factors. For example, the Service has initiated discussions and evaluations with the U.S. Forest Service to address the factors causing the decline and lack of adequate growth at Croatan National Forest (-1.3%). Bienville National Forest, with a 2.2% growth rate, had not been growing adequately until 2007, and has been the subject of Service and Forest Service discussions on limiting factors. Bienville, currently, is developing a RCW habitat restoration plan. The population at Sam Houston National Forest experienced a decline during 2003-2005, apparently because of hardwood encroachment, which became the subject of intensified management that has reversed the trend. Also, the Service plans to initiate a review this year with the U.S. Forest Service to assess the decline on the Oakmulgee Ranger District-Talladega National Forest (-4.0%).

In other instances, the observed net 5-year decline clearly has not been due to a lack of management, but a combination of unavoidable natural factors and other circumstances, as in certain properties in the South Central Florida Recovery Unit. These will not continue to decline.

Given the general relationships between property-population size, growth (Appendix C Figure 2), and management, an alternative approach to estimating future population size and time trend is to use a geometric growth rate representative of recent trends without significant management problems or limitations. This assumes, with reasonable justification, that the Service and managing agencies will identify and implement management solutions to the limiting factors contributing to any declining trend. Thus, the past 5-year declining growth trends at some properties are not considered representative of a future trend, and will be deleted from growth rate estimates (Appendix C Table 6). Three other properties with negative growth rates were included because these largely are considered a response to uncontrollable, temporary natural factors.

Of the 59 recovery properties with recent 5-year growth rate data, 48 were selected as properties with representative levels of recovery management, without significant problems to be resolved. Effects of population property size classes (active clusters) on the 5-year average annual geometric growth rates for each size class were assessed by a nonparametric ANOVA and a generalized ANOVA. The population property size classes were 1-25, 26-20, 51-100, and 100+ active clusters. Each class was considered to represent a relatively homogeneous range of growth rate variation (Appendix C Figure 3). Property population growth rates were affected by size class intervals (Kruskal-Wallis ANOVA H (3, n=48) = 0.1091, p = 0.0279; GLM ANOVA log-likelihood = -155.295, chi-square = 8.4446, p = 0.0377). Mean growth rates declined as property population size class increased. Mean growth rates were similar among the 1-25, 26-50, and 51-100 size classes (8.34 – 7.11%), all of which exceed 5 percent annually, and were much greater than the lower mean rate for the 101+ population size class (2.26%, Appendix C Table 1).

As an updated estimate to the Recovery Plan method, the mean annual percent growth rate for each property population size class (Appendix C Table 1) was used to project the future growth of each property population and the time to achieve either the designated property recovery size objective or property management size objective. The initial size for each property population was the number of active clusters reported in 2007. Each property population with less than 25 active clusters was projected forward based on the mean property size class geometric growth rate until a size of 25 was reached. The time required to attain 25 was recorded for each population. The Hal Scott Preserve was the only recovery property with a recovery goal of less than 25 active clusters (e.g. 15 PBGs, 19 active clusters). The time to achieve this objective represented the time to achieve the property recovery objective. All other properties at the year of attaining 25 active clusters were projected again based on the mean geometric growth rate for the 26-50 property size class to the time required to attain either 50 active clusters, or if less, the property recovery or management objective. Population growth was modeled for each population in the 51-100 size class using the mean size class growth rate, and the 101+ size class and growth rates until either the time to achieve to population size objective was attained. Initial populations (2007 active clusters) with greater than 25 active clusters were projected forward beginning in their respective population size class, by the same procedure until the property size objective was obtained.

Table 1. Average annual percent growth, reliable properties, by property RCW "population" size class (active clusters.)

a. All properties

Active Clusters	N	Mean	Std.Er.	95% C.I.	Range	Median
1 – 25	19	4.02	1.58	0.86 – 7.19	-12.94 – 23.36	3.13
26 – 50	15	7.43	1.78	3.87 – 10.99	-1.65 – 25.83	6.50
51 – 100	12	6.29	1.99	2.34 – 10.27	-1.28 – 14.87	5.00
101+	13	1.78	1.91	-20.4 – 5.61	-3.99 – 5.74	2.38
Overall	59	4.86	0.91	3.03 – 6.69	-12.94 – 25.83	3.40

b. Representative properties.

Active Clusters	N	Mean	Std.Er.	95% C.I.	Range	Median
1 – 25	12	8.34	1.70	4.92 – 11.76	-3.04 – 23.36	7.51
26 – 50	14	8.04	1.57	4.87 – 11.21	-1.65 – 25.83	7.32
51 – 100	10	7.11	1.86	3.36 – 10.86	0.00 – 14.87	6.37
101+	12	2.26	1.70	-1.16 – 5.68	-1.47 – 5.74	2.49
Overall	48	6.48	0.90	4.67 – 8.28	-3.04 – 25.83	3.97

Table 2. Percent potential breeding pairs (%PBGs) in active clusters, with transformations, tests for normality, and basic statistics from 37 property populations in 2007. Transformed data reported as back-transformed values.

Variable	Shapiro-Wilk's W	Shapiro-Wilk's p	Mean	Std.error	95% C.I.	Median
%PBGs	0.9316	0.0250	89.9	1.19	87.4 – 92.3	89.3
Ln %PBGs	0.9150	0.0079	89.5	1.01	87.1 – 92.1	89.2
log %PBGs	0.9150	0.0079	89.6	1.01	87.1 – 92.1	89.2
Sqrt %PBGs	0.9242	0.0149	89.7	0.004	87.2 – 92.2	89.3
Arcsin-sqrt %PBGs	0.8933	0.0019	91.9	--	88.8 – 94.5	89.3
Arcsin-sqrt %PBGs B	0.9290	0.0208	--	--	--	--
Arcsin-sqrt %PBGs C	0.9268	0.0179	--	--	--	--

Table 3. Generalized linear model for response of percent PBGs to population size (active clusters).

Effect	Estimate	Std. error	Wald statistic	P
Intercept	88.5212	1.5185	3398.4820	0.0000
Population size	0.01378	0.0103	1.790	0.1809

Table 4. Effects of initial population size (active clusters, AC_i and potential breeding groups, PBG_i) ratio of active clusters to potential breeding groups (AC:PBG, equal to the proportion of breeding groups in active clusters, PBGs/ACs) to the time (years) to reach a primary core population of 350 PBGs at 0.05 and 0.025 average annual geometric growth rates. The percent reduction in time (%Time Reduction) is number of years at the AC:PBG ratio at which the time to reach the population recovery objective is reduced relative to the greatest period of time at a 1.4 AC:PBG ratio, expressed as a percentage.

AC_i	AC:PBG	PBGs/ACs	PBG_i	AC_f	Years @ Growth Rate 0.05	Years @ Growth Rate 0.025	% Time Reduction
25	1.4286	0.70	17.5	500.00	61.4	121.3	0.0
	1.3333	0.75	18.8	466.7	60.0	118.5	1.9
	1.2500	0.80	20.0	437.5	58.7	115.9	3.8
	1.1765	0.85	21.3	411.8	57.4	113.5	5.8
	1.1111	0.90	22.5	388.9	56.2	111.1	7.8
	1.0526	0.95	23.8	368.4	55.1	109.9	9.8
	1.0000	1.00	25.0	350.0	54.1	106.9	11.9
50	1.4286	0.70	35.0	500.00	47.2	93.2	0.0
	1.3333	0.75	37.5	466.7	45.8	90.5	2.6
	1.2500	0.80	40.0	437.5	44.5	87.8	5.1
	1.1765	0.85	42.5	411.8	43.2	85.4	7.7
	1.1111	0.90	45.0	388.9	42.0	83.1	10.3
	1.0526	0.95	47.5	368.4	40.9	80.9	12.9
	1.0000	1.00	50.0	350.0	39.9	78.8	15.5
75	1.4286	0.70	52.5	500.00	38.9	76.8	0.0
	1.3333	0.75	56.3	466.7	37.5	74.0	3.2
	1.2500	0.80	60.0	437.5	36.1	71.4	6.4
	1.1765	0.85	63.8	411.8	34.9	69.0	9.5
	1.1111	0.90	67.5	388.9	33.7	66.7	12.7
	1.0526	0.95	71.3	368.4	32.6	64.5	15.7
	1.0000	1.00	75.0	350.0	31.6	62.4	18.8
100	1.4286	0.70	70.0	500.00	33.0	65.2	0.0
	1.3333	0.75	75.0	466.7	31.6	62.4	3.9
	1.2500	0.80	80.0	437.5	30.3	59.8	7.8
	1.1765	0.85	85.0	411.8	29.0	57.3	11.5
	1.1111	0.90	90.0	388.9	27.8	55.0	15.1
	1.0526	0.95	95.0	368.4	26.7	52.8	18.7
	1.0000	1.00	100.0	350.0	25.7	50.7	22.2

AC_f – the final number of active clusters at a population of 350 potential breeding groups.

Table 5. Effects of initial population size (active clusters, AC_i and potential breeding groups, PBG_i) ratio of active clusters to potential breeding groups (ACs:PBGs, equal to the proportion of breeding groups in active clusters, PBGs/ACs) to the time (years) to reach a secondary core population of 250 PBGs at 0.05 and 0.025 average annual geometric growth rates. The percent reduction in time (%Time Reduction) is number of years at the AC:PBG ratio at which the time to reach the population recovery objective is reduced relative to the greatest period of time at a 1.4 AC:PBG ratio, expressed as a percentage.

					Years @ Growth Rate		% Time
AC_i	ACs:PBGs	PBGs/ACs	PBG_i	AC_f	0.05	0.025	Reduction
	1.4286	0.70	17.5	357.2	54.5	107.7	0.0
	1.3333	0.75	18.8	333.3	53.1	104.9	2.2
25	1.2500	0.80	20.0	312.5	51.8	102.3	4.4
	1.1765	0.85	21.3	294.1	50.5	99.8	6.6
	1.1111	0.90	22.5	277.8	49.4	97.5	8.8
	1.0526	0.95	23.8	263.2	48.2	95.3	11.1
	1.0000	1.00	25.0	250.0	47.2	93.2	13.4
	1.4286	0.70	35.0	357.2	40.3	79.6	0.0
	1.3333	0.75	37.5	333.3	38.9	76.8	3.1
50	1.2500	0.80	40.0	312.5	37.6	74.2	6.1
	1.1765	0.85	42.5	294.1	36.3	71.8	9.2
	1.1111	0.90	45.0	277.8	35.1	69.4	12.2
	1.0526	0.95	47.5	263.2	34.0	67.3	15.2
	1.0000	1.00	50.0	250.0	33.0	65.2	18.1
	1.4286	0.70	52.5	357.2	32.0	63.2	0.0
	1.3333	0.75	56.3	333.3	30.6	60.4	4.1
75	1.2500	0.80	60.0	312.5	29.3	57.8	8
	1.1765	0.85	63.8	294.1	28.0	55.3	11.9
	1.1111	0.90	67.5	277.8	26.8	53.0	15.6
	1.0526	0.95	71.3	263.2	25.7	50.8	19.3
	1.0000	1.00	75.0	250.0	24.7	48.8	22.9
	1.4286	0.70	70.0	357.2	26.1	51.6	0.0
	1.3333	0.75	75.0	333.3	24.7	48.8	5.3
100	1.2500	0.80	80.0	312.5	23.4	46.1	10.3
	1.1765	0.85	85.0	294.1	22.1	43.7	15.1
	1.1111	0.90	90.0	277.8	20.9	41.4	19.6
	1.0526	0.95	95.0	263.2	19.8	39.2	23.9
	1.0000	1.00	100.0	250.0	18.8	37.1	28.0

Table 6. Property-populations with average annual geometric growth rates excluded from analysis.

Property	Active Clusters 2007	Growth Rate	Factor
Ochlockonee River State Park	2	0.0	Minor property, with a goal of 3 ACs, small changes to small pop generates large rates
Weymouth Woods State Nature Preserve	4	-7.8	Small goal of 8 ACs, with small changes generating large rates
Dare County Bombing Range	5	-3.6	Significant habitat restoration and management issues to be resolved in pocosin habitat.
McCain Tract	6	8.4	Small property, with a property goal of 7 ACs
Pocosin Lakes National Wildlife Refuge	6	0.0	Comprehensive management not initiated, with significant restoration issues in pocosins.
Tate's Hell State Forest	20	-7.8	Limiting management factors will be reduced.
Holly Shelter Game Lands	36	-1.1	Management goal of 39 ACs nearly attained, recruitment reduced as goal approaches.
Big Cypress National Preserve	57?	5.7	Data since 2004 may not be reliable.
Croatan National Forest	60	-1.3	Management limitations expected to be reduced.
Oakmulgee RD, Talladega NF	102	-4.0	Management limitations expected to be reduced.
Alligator River National Wildlife Refuge	1	-12.9	Small population and significant restoration management issues in pocosin.

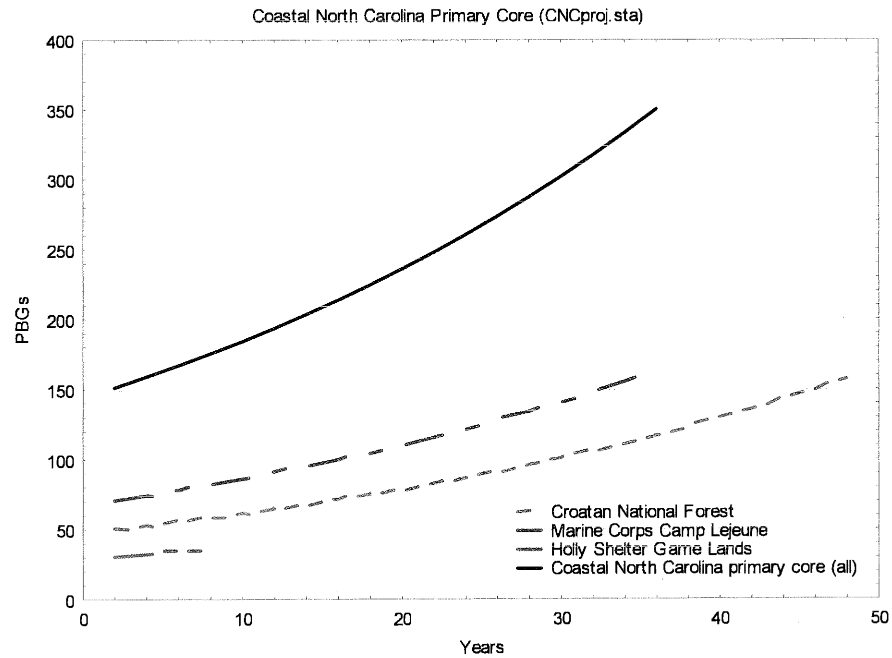

Figure 1. Future growth of the Coastal North Carolina primary core population, as a single demographic unit, relative to growth of its three constituent properties if they are not a single population, and the time required to reach a population of 350 PBGs. Projection based on 2007 estimated PBGs, 0.025 average

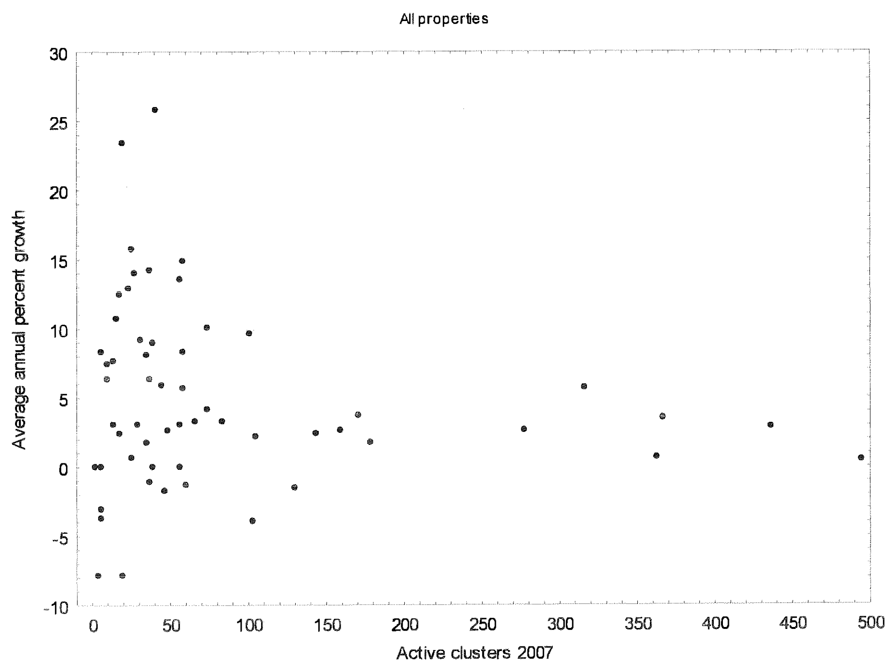

Figure 2. Active clusters in 2007 from 59 recovery properties in relation to average annual geometric growth for the 5-year period 2002-2007.

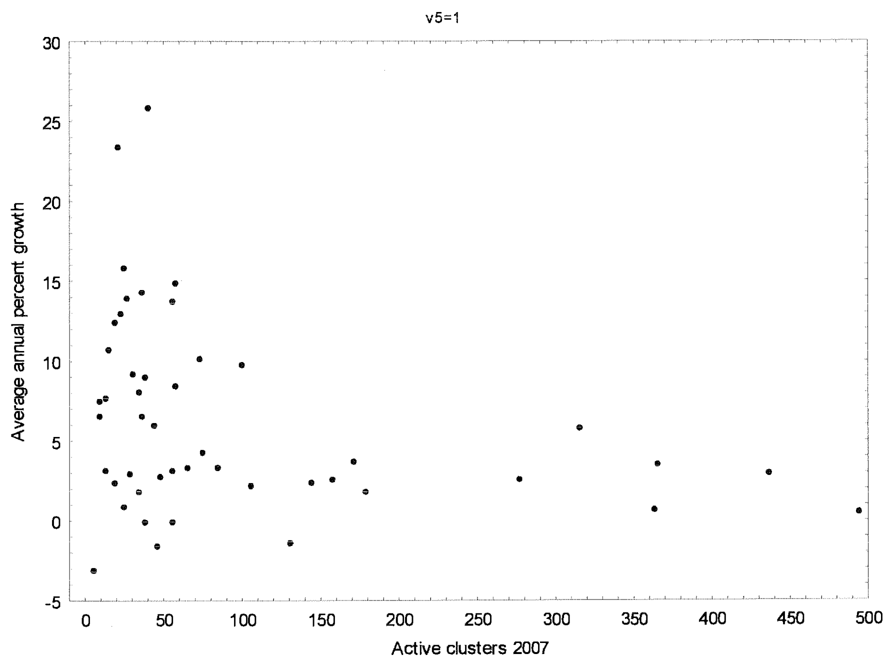

Figure 3. Active clusters in 2007 from 48 selected recovery properties in relation to average annual geometric growth for the 5-year period 2002-2007

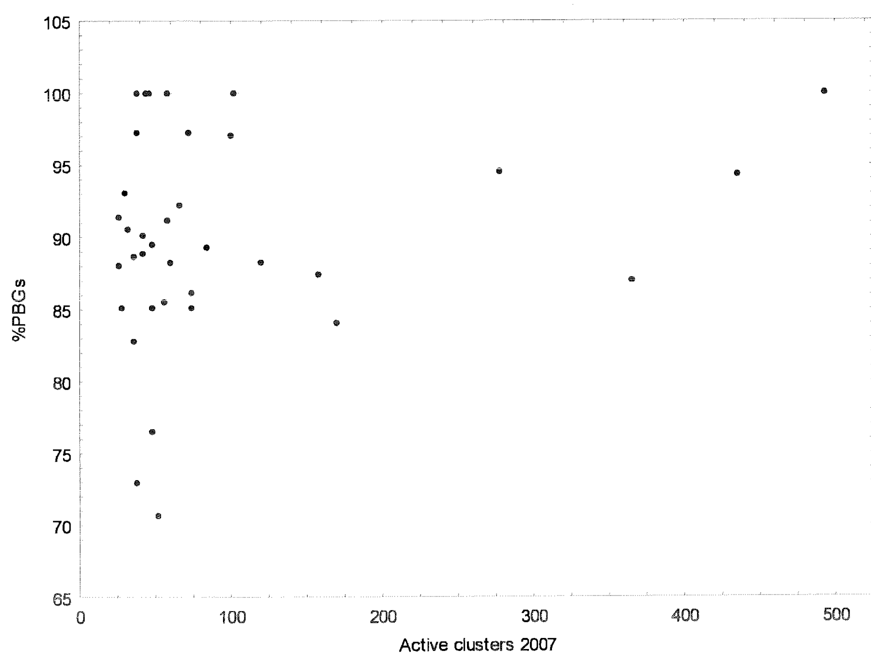

Figure 4. Active clusters (2007) from 37 properties managed for RCWs, reporting adequate data in the RCW annual report data base for their corresponding percent of active clusters with PBGs.