RED-COCKADED WOODPECKER (*PICOIDES BOREALIS*) RECOVERY AND SUSTAINMENT PROGRAM

Programmatic Biological Assessment

for

Marine Corps Installations East –
Marine Corps Base Camp Lejeune

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Final
July 2012






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Executive Summary

The primary purpose of this Programmatic Biological Assessment (PBA) for the Red-cockaded Woodpecker (RCW) Recovery and Sustainment Program (RASP) is to develop an achievable process that allows Marine Corps Installations East – Marine Corps Base Camp Lejeune (MCB Camp Lejeune) Range and Training Area (RTA) to be developed or reconfigured in a timely manner to maintain and enhance operational and training flexibility. The overall end-state is to allow for the development of new training ranges to support existing and future II Marine Expeditionary Force (II MEF) pre-deployment, warfighting requirements for all elements of the Marine Air-Ground Task Force (command and control element, ground combat element, logistic element, and aviation element). The PBA was prepared by a team that included MCB Camp Lejeune personnel and United States Fish and Wildlife Service (USFWS) personnel with contractor support from Geo-Marine, Incorporated (GMI).

The document and its review and approval are being done in accordance with Section 7 of the Endangered Species Act (ESA), which regulates Interagency Coordination. The document is in the format of a Biological Assessment (BA), and the USFWS will provide a separate Biological Opinion (BO) to support their conclusions regarding the effect of the program on listed species.

The RASP is intended to establish a process by which properties with the potential to increase the RCW population can be identified, evaluated, protected, and managed in perpetuity, thereby enhancing the recovery of the CNCPC population. In return, the RCW recovery goal at MCB Camp Lejeune can be reduced, helping to sustain the military mission.

To implement the RASP the Marine Corps intends to enter into agreements or contracts with agencies, non-government organizations or private landowners to fund the management of RCW on off-base properties. This implementation may include purchase of conservation easements, and/or funding of short and long-term management costs directly or through a third party.

The general methodology of the RASP includes:

- Phase I: Information Gathering and Preliminary Analyses
- Phase II: Analysis of the Biological Function of an Identified Property;
- Phase III: USFWS Notification and Determination of Functionality;
- Phase IV: Formulation of Agreements to Protect RCW Habitat in Perpetuity (between MCB Camp Lejeune and the State and non-federal property owner); and
- Phase V: USFWS Final Approval of Reduction in Recovery Goal for MCB Camp Lejeune.

Properties to be included in the program will be analyzed using state-of-the-art computer population models which include the Decision Support System (DSS) model developed by Dr. Jeff Walters and the Landscape Equivalency Analysis/Pattern Oriented Modeling (LEA/POM) techniques developed by Dr. Doug Bruggeman.

Reduction in the recovery goal will be subject to the following general conditions and processes:

- MCB Camp Lejeune will continue to manage habitat on the installation for RCW.
- Reduction in the MCB Camp Lejeune RCW recovery goal does not authorize "take" (impacting active clusters) of RCW on MCB Camp Lejeune. However during the Section 7 evaluation of a proposed action involving "take", all protected and managed habitat and clusters that provide a biological function to the CNCPC population can be used in the determination of jeopardy/non-jeopardy. This means that the baseline to be used for Section 7 consultations can be expanded to include the entire CNCPC population when necessary to fully evaluate impacts and/or benefits to the population of a proposed action. Previous consultations were conducted entirely "within the fence" of MCB Camp Lejeune. This approach will benefit MCB Camp Lejeune by reducing the importance of MCB Camp Lejeune RTAs to support the overall population. The purpose of the RASP is to enhance the Marine Corps' position during consultations for training impacts in the Range and Training Area (RTA) that will likely involve "take", by expanding the geographic area in which to meet the core population recovery goal. Recently developed computer population modeling techniques including the DSS and LEA/POM are tools available for helping to evaluate the effects of a project on factors such as RCW abundance and persistence, genetic drift, and inbreeding. These tools will be utilized as necessary to ensure that "best available science" is used to inform decisions regarding potential impacts to RCW.
- The USFWS final approval of a RASP property is provided when an agreement is reached with the landowner that meets the requirements of this programmatic agreement.
- Restrictions on military training will be reduced by effectively increasing the amount of the CNCPC population goal that is supported on conservation land and reducing the goal on lands required for military training.

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ACKNOWLEDGEMENTS

The following individuals contributed to the conceptualization of the Recovery and Sustainment Program and the production of this document in a cooperative effort between Marine Corps Base Camp Lejeune, the U.S. Fish and Wildlife Service, and Geo-Marine, Inc.:

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LIST OF ACRONYMS AND ABBREVIATIONS

BO	Biological Opinion
CNCPC	Coastal North Carolina Primary Core
CPI	Consumer Price Index
dbh	Diameter Breast Height
D_{ST}	Average Genetic Divergence among Breeding Groups
DoD	Department of Defense
DoI	Department of Interior
DoN	Department of the Navy
DSS	Decision Support System
ESA	Endangered Species Act
F	Average Rate of Inbreeding
FEMA	Federal Emergency Management Agency
GAP	Gap Analysis Program
GIS	Geographical Information System
GMI	Geo-Marine, Inc.
GSRA	Greater Sandy Run Area
H_S	Average Expected Heterozygosity Rate within Breeding Groups
Holly Shelter	Holly Shelter State Game Lands
IB-SEPM	Individual-based, Spatially-explicit Population Model
INRMP	Integrated Natural Resource Management Plan
JEP	Johnson-Emigh-Pollak
LEA	Landscape Equivalency Analysis
LiDAR	Light Detection and Ranging
MAGTF	Marine Air-Ground Task Force
MARSOC	Marine Corps Forces Special Operations Command
MCB	Marine Corps Base
MCIEAST	Marine Corps Installations East
MEF	Marine Expeditionary Force
MILCON	Military Construction
MOU	Memorandum of Understanding
MOUT	Military Operations in Urban Terrain

LIST OF ACRONYMS AND ABBREVIATIONS (cont'd)

NAIP	National Agricultural Imagery Program
NCNHP	North Carolina Natural Heritage Program
NCOBCF	North Carolina Onslow Bight Conservation Forum
NCSH	North Carolina Sandhills
NCSU	North Carolina State University
NCWRC	North Carolina Wildlife Resources Commission
NF	National Forest
NGO	Non-governmental Organization
PBA	Programmatic Biological Assessment
PBG(s)	Potential Breeding Group(s)
POM	Pattern-oriented Modeling
PVA	Population Viability Analysis
RASP	Recovery and Sustainment Program
RCP	Recovery Credit Program
RCW	Red-cockaded Woodpecker
RTA	Range and Training Area
SERDP	Strategic Environmental Research and Development Program
Service	United States Fish and Wildlife Service
SRS	Savannah River Site
TNC	The Nature Conservancy
U.S.	United States
USC	United States Code
USDA	United States Department of Agriculture
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
USMC	United States Marine Corps
UTM	Universal Transverse Mercator

1.0 INTRODUCTION

1.1 PURPOSE

The primary purpose of this Programmatic Biological Assessment (PBA) for the Red-cockaded Woodpecker (RCW) Recovery and Sustainment Program (RASP) is to develop an achievable process that allows Marine Corps Installations East - Marine Corps Base Camp Lejeune (MCB Camp Lejeune) Range and Training Area (RTA) to be developed or reconfigured in a timely manner to maintain and enhance operational and training flexibility while promoting recovery of the RCW. The overall end-state is to allow for the development of new training ranges to support existing and future II Marine Expeditionary Force (MEF) pre-deployment, warfighting requirements for all elements of the Marine Air-Ground Task Force (MAGTF). The MAGTF includes a command and control element, ground combat element, logistic element, and an aviation element. Training ranges span the warfighting spectrum from small arms training to large-scale collective exercises. In aggregate, training range capabilities include individual skills (small arms, military operations in urban terrain [MOUT] training), collective skills (units, to include armor and mechanized, maneuver with live-fire to objectives), and large-scale exercises such as Marine Expeditionary Unit certifications (battalion level) and Joint Task Force exercises (regimental level). The warfighting capabilities and employment methods are currently resident in existing Marine Corps doctrinal publications, Training and Readiness Manuals, Mission Essential Tasks, and Commandant's guidance, but cannot be executed to standard to function as a coherent MAGTF maneuver warfighting force. In achieving the latter end-state, MCB Camp Lejeune will seek to promote recovery of RCW and achieve a net benefit to training.

As a federal agency, the United States (U.S.) Marine Corps (USMC) is required under the Endangered Species Act of 1973 (16 United States Code [USC] 1531 et seq.), as amended (ESA), to utilize its authorities to implement conservation programs in furtherance of the purposes of the act as well as ensure that no actions jeopardize the continued existence of a listed endangered or threatened species. Department of Defense (DoD) policy requires that "DoD shall demonstrate stewardship of natural resources in its trust by protecting and enhancing those resources for mission support, biodiversity conservation, and maintenance of ecosystem services." Likewise, Marine Corps policy requires that "installation and unit commanders must work to guarantee continued access to our land, air, and water resources for realistic military training and testing by ensuring that the natural resources entrusted to the Marine Corps' care remain healthy and available for future generations."

As stewards for over 130,000 acres of federal land, MCB Camp Lejeune uses an ecosystem-based approach with respect to natural resource management; however, special attention is given to threatened and endangered species and their habitats to manage for conservation and recovery of those species. Consequently, MCB Camp Lejeune has implemented programs to manage the

seven federally listed species and their habitats in order to ensure ecological function, sustainment, and the recovery of these vulnerable populations both on and off the installation.

The RCW was listed as federally endangered in 1970, becoming one of the first species protected by the ESA. This species was found throughout the pine woods and savannahs of the southeastern U.S., and its historical range encompasses eastern North Carolina. Existing RCW populations on MCB Camp Lejeune play an important role in the recovery of this species as one of the three subpopulations that make up the Coastal North Carolina Primary Core (CNCPC) population (Figure 1-1).

The USMC is exploring the potential benefits to listed species and to the military mission that may result from cooperative RCW management with agencies, organizations, and landowners within the CNCPC population. Entitled the RASP, this program is intended to establish a process by which properties with the capability to enhance RCW conservation can be identified, protected, and managed in perpetuity, thereby enhancing the recovery of the CNCPC population. In return, the RCW recovery goal at MCB Camp Lejeune can be reduced, helping to sustain the military mission. Properties considered for inclusion in the RASP will be evaluated for their ability to:

1) Establish and sustain new subpopulations or additions to existing subpopulations of RCW;
2) Provide suitable foraging habitat for RCW, endangered, threatened, and other at risk species endemic to the longleaf pine (*Pinus palustris*) ecosystem
3) Help create biological corridors (e.g., dispersal habitat) between existing subpopulations or between existing subpopulations and new subpopulations.

Properties to be included in the program may be able to provide immediate habitat and establishment of RCW clusters, or may require an investment in time and management to provide benefits to the species in the future.

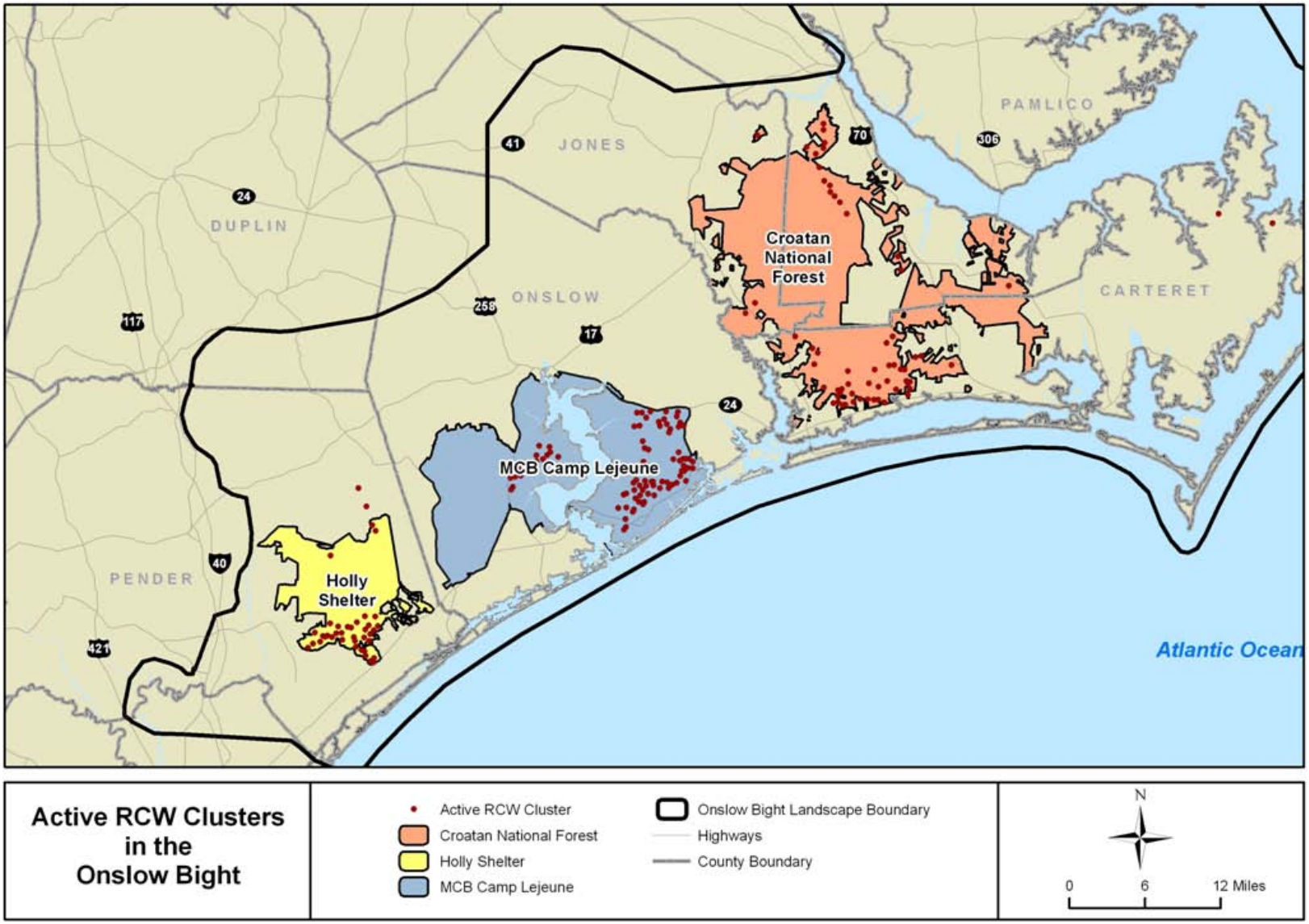

Figure 1-1. Active RCW Clusters and the Three Primary Properties of the CNCPC RCW Population: Holly Shelter, MCB Camp Lejeune, and Croatan National Forest.

1.2 RATIONALE FOR PROGRAMMATIC BIOLOGICAL ASSESSMENT

Over the last 5 years, the parties have worked cooperatively to identify a strategy that would meet the recovery goals for the CNCPC population as defined in the RCW Recovery Plan (USFWS 2003). Formally and informally, the U.S. Fish and Wildlife Service (USFWS; Service) and MCB Camp Lejeune have worked closely to perform base-line analyses on the species' status and distribution and the ecological function of the current and potential future RCW population in the CNCPC population. Other reliable data, such as published studies, species accounts, and peer-reviewed journal articles have also been considered. Biologists have developed a methodology to assess the current and future potential of properties to support and enhance the CNCPC population. The work completed up to this point has led to a conclusion that within the Project Area landscape significant opportunities exist to restore and/or improve RCW habitat and establish new groups of RCW.

MCB Camp Lejeune and the USFWS believe a programmatic approach is appropriate because evaluation and approval of properties for inclusion in the RASP is intended to be an ongoing process. An approved programmatic document provides the assurances needed to justify the investment in projects that have the potential to meet conditions and requirements of the RASP and reduce restrictions on military training.

1.3 CONSULTATION HISTORY

04/06/2006 – The Environmental Conservation Branch Head, MCB Camp Lejeune sent an e-mail to the Service Raleigh Field Office and the RCW Recovery Coordinator briefly describing the installation's interest in beginning a regional RCW conservation initiative.

04/27/2006 – The Environmental Conservation Branch Head, MCB Camp Lejeune forwarded an e-mail to the RCW Recovery Coordinator providing additional details on processes available to the USMC, including the Encroachment Partnering Program that may facilitate expansion of the RCW conservation landscape within the Onslow Bight area and recommending the Service provide written support for these efforts.

04/28/2006 – The Service RCW Recovery Coordinator sent a facsimile of his April 28, 2006 letter to the Environmental Conservation Branch Head, MCB Camp Lejeune briefly outlining RCW recovery objectives for the CNCPC population, identifying the benefits of such efforts to relieving environmental restrictions associated with RCW protection, and encouraging the USMC to continue seeking conservation easements within the CNCPC population area.

05/03/2006 – The Environmental Conservation Branch Head, MCB Camp Lejeune sent an e-mail to the Service Raleigh Field Office and the RCW Recovery Coordinator acknowledging receipt of the Coordinator's April 28, 2006 letter and suggesting that the

Service, USMC, the North Carolina Wildlife Resources Commission (NCWRC), and potentially others participate in a Memorandum of Understanding (MOU) for promoting reduction of MCB Camp Lejeune's RCW recovery objectives.

06/06/2006 – The Environmental Conservation Branch Head, MCB Camp Lejeune forwarded an electronic copy of a letter to the Field Supervisor of the Service Raleigh Field Office proposing the development of an MOU for enhancing RCW conservation off base and requesting notional concurrence with the application of a MCB Camp Lejeune RCW credit system.

09/07/2006 – The Service provided a September 7, 2006 letter agreeing with MCB Camp Lejeune's statement that the development of a RCW credit system could provide RCW conservation benefits to the CNCPC population while further alleviating constraints on the installations ability to conduct military training and infrastructural development.

05/01/2007 – The Director Environmental Management, MCB Camp Lejeune sent an e-mail to the Service Raleigh Field Office, the RCW Recovery Coordinator, The Nature Conservancy (TNC), and North Carolina State University (NCSU) requesting their participation in a group to develop a course of action to promote the installation's attainment of its RCW recovery goal (173 active clusters).

05/31/2007 – MCB Camp Lejeune hosted a meeting with the objective "to examine alternatives for generating RCW recovery credit for MCB Camp Lejeune outside of the installation and develop a practical course of action for moving forward."

12/20/2007 – Fort Bragg hosted a meeting with MCB Camp Lejeune and Marine Corps Installations East (MCIEAST) staff to discuss processes used by the Army to establish conservation for RCWs on private land in the Fort Bragg area, appropriate application of partnering and funding, and other subjects related to supporting RCW recovery and compatible land use.

05/29/2008 – MCB Camp Lejeune hosted a meeting with the Service to discuss RCW recovery credit concepts that may be considered for application in the lands adjacent to and within vicinity of the installation. The Service emphasized the value of scientific research in directing RCW conservation efforts and the importance of demographic functioning to the achievement of species recovery.

6/20/2008 – John Hammond of the Service Raleigh Field Office attended a meeting on MCB Camp Lejeune to discuss the development of the scope of work for the installation's "Forest/Red-cockaded Woodpecker Credit Biological Assessment/Habitat Inventory." The meeting was held to determine steps for MCB Camp Lejeune to follow in pursuit of RCW conservation credit on properties close in to the installation.

10/14/2008 – Doug Bruggeman, developer of the population modeling process that includes Landscape Equivalency Analysis (LEA) and pattern-oriented modeling (POM) provided a presentation to the Onslow Bight RCW working group. Dr. Bruggeman's presentation demonstrated the scientific challenges involved in trading habitat for federally protected species and provided an overview of the potential application of his research to evaluating recovery crediting RCWs within the Onslow Bight focus area. The meeting was held at the Hammock's Beach State Park office and was attended by NCWRC, U.S. Forest Service, USFWS, USMC, and TNC staff.

11/14/2008 – MCB Camp Lejeune hosted a meeting with TNC, Coastal Land Trust, USFWS, and Navy contracting staff to develop a contract through which off-base properties would be assessed for RCW conservation potential and whether or not such properties might contribute to the installation's effort to reduce recovery responsibilities on base and promote the species recovery in the population unit. The installation presented a new scope of work for RCW habitat and assessment and credit biological assessment. MCB Camp Lejeune listed six properties to be evaluated: Holly Shelter State Gamelands (Holly Shelter), Bear Garden State Game Lands, Shaken Creek, Stones Creek State Game Lands, Hofmann Forest Block 10, and the Everett Creek – Allen Property.

11/20/2008 – The Service RCW Recovery Coordinator forwarded e-mail to Head, Environmental Conservation Branch, MCB Camp Lejeune recommending that the Service and MCB Camp Lejeune schedule a meeting or conference call to discuss emerging issues including the addition of pattern-oriented modeling to the Base's on-going RCW population modeling.

1/08/2009 – MCB Camp Lejeune held a brief for the Commanding General, MCIEAST to explain the purpose of MCIEAST's contract with Texas A&M University and within the State of North Carolina to promote a RCW recovery system to include 44 counties within the State. The brief was attended by Service Field Supervisor, Raleigh Field Office.

02/06/2009 – MCB Camp Lejeune hosted a RCW recovery meeting attended by a broad range of stakeholders to discuss the need to improve the installation's training ranges and infrastructure, the biological needs of the species to be considered in planning for RCW recovery, and the opportunities for achieving species recovery through population growth outside of the MCB Camp Lejeune boundaries.

02/13/2009 – Meeting with Dr. Jeffrey R. Walters, Doug Bruggeman, John Ouellette, Gary Haught, and others at Virginia Polytechnic Institute and State University to discuss processes for analyzing the application of a recovery system for MCB Camp Lejeune.

04/01/2009 – MCB Camp Lejeune hosted a meeting with the Service RCW Recovery Coordinator, Endangered Species Coordinator from the Raleigh Field Office, Base

Environmental Conservation Staff, and Geo-Marine, Inc. (GMI) Representatives to identify modeling scenarios to "fine tune" the focus of off-base RCW recovery efforts.

04/16/2009 – MCB Camp Lejeune, the USFWS, and the U.S. Forest Service convened a meeting at Hammocks Beach State Park to discuss issues pertaining to recovery of the CNCPC population. MCB Camp Lejeune described their local recovery crediting efforts. Discussion included ways in which MCB Camp Lejeune may be able to assist the Forest Service in promoting recovery of RCWs in the Croatan National Forest (NF) such that enhancing conservation of extra RCW groups within the Croatan NF meta-populations might count toward a reduction in MCB Camp Lejeune's recovery goal.

05/27/2009 – RCW Crediting System Meeting, New Bern, North Carolina. MCB Camp Lejeune and NCWRC staff.

09/11/2009 – the Service forwarded a letter to the Commanding General, MCIEAST expressing the Service RCW conservation perspective with regard to recovery of the CNCPC population in light of a 44-county approach. Specifically, the Service explained that efforts to establish RCW ecosystems services away from the meta-populations that fall within the CNCPC population may not necessarily contribute to RCW recovery in a meaningful way.

09/29/2009 – MCB Camp Lejeune provided the Service with a draft programmatic biological assessment for a RCW recovery credit program (RCP) for the CNCPC population.

10/07/2009 – the Commanding General, MCIEAST responded to the Service's September 11, 2009 letter indicating that USMC is confident that MCB Camp Lejeune plans to establish RCW conservation on properties immediately adjacent to the CNCPC population meta-populations will meet current and future training requirements, and remains the USMC's highest priority process for meeting the stated conservation objectives, the USMC intends to consider other options as a contingency.

10/07/2009 – MCB Camp Lejeune hosted a meeting to discuss the potential for the Oak Island property to serve as a conservation bank for RCWs in a way that contributes to recovery of the CNCPC population.

10/08/2009 – MCB Camp Lejeune hosted a meeting to discuss the installation's RCW credit project and brief the Service on plans for meeting future military training requirements.

10/20/2009 – MCB Camp Lejeune organized a conference call with the Service RCW Recovery Coordinator, the Raleigh Field Office, Dr. Bruggeman, and MCB Camp Lejeune Environmental Conservation Branch staff to determine the most productive scenarios (parameterizations) to run using LEA.

11/03/2009 – The Environmental Conservation Branch Head, MCB Camp Lejeune forwarded an electronic copy of a list of scenarios for the Bruggeman model to the RCW Recovery

Coordinator and the Raleigh Field Office requesting input to ensure the modeling would provide results for directing off-base conservation activities.

11/18/2009 – The Service RCW Recovery Coordinator provided a brief e-mail outlining additional information to include in output reports from Dr. Bruggeman's model runs.

11/19/2009 – Dr. Bruggeman submitted an electronic copy of the updated proposal for model runs to the Environmental Conservation Branch Head, MCB Camp Lejeune based on comments provided by the RCW Recovery Coordinator.

02/02/2010 - The Environmental Conservation Branch Head, MCB Camp Lejeune e-mailed the RCW Recovery Coordinator to inform him that the contract was in place with GMI to begin providing Dr. Bruggeman with data for operating the LEA/POM model simulations.

02/18/2010 - MCB Camp Lejeune organized a conference call with the Service RCW Recovery Coordinator, the Raleigh Field Office, Dr. Bruggeman, and MCB Camp Lejeune Environmental Conservation Branch staff to further fine-tune parameters LEA/POM model simulations, including the running of scenarios with and without translocations in simulations.

2/19/2010 – The Service RCW Recovery Coordinator forwarded e-mail to the MCB Camp Lejeune Environmental Conservation Branch Head providing additional details pertaining to the planned simulations.

07/27/2010 - The Environmental Conservation Branch Head, MCB Camp Lejeune e-mailed the RCW Recovery Coordinator to inform him that GMI would soon be providing the Service with a link to the report of progress made by Dr. Bruggeman in simulating population behavior for the list of properties (e.g., Stones Creek Game Lands, Bear Garden, Shaken Creek, etc.) based on the agreed-upon parameterizations and to request to schedule a meeting between MCB Camp Lejeune and the Service.

08/06/2010 – MCB Camp Lejeune and the Service RCW Recovery Coordinator and Raleigh Field Office joined in a conference call to discuss Dr. Bruggeman's July 21, 2010 report on LEA/POM analyses.

09/09/2010 – the Service Raleigh Field Office hosted a meeting attended by MCB Camp Lejeune and the Service RCW Recovery Coordinator to discuss details regarding knowledge gained from Dr. Bruggeman's LEA/POM report and how those data would be used to analyze the ecological functioning of properties adjacent to MCB Camp Lejeune and Holly Shelter as habitat to support RCW population growth supplemental to currently existing populations.

9/28/2010 – MCB Camp Lejeune forwarded a letter to the Field Supervisor, Raleigh Field Office summarizing the progress the installation has made toward the establishment of a RCW

RCP. The letter made reference to on-going negotiations between the NCWRC over RCW management on state-owned property and requested the Service recognize the reduction of the installation's recovery goal by the number of active clusters that could be established on identified properties in the event that negotiations are successful and permanent conservation could be attained.

09/30/2010 – the Service RCW Recovery Coordinator submitted a memorandum to Dr. Bruggeman and the MCB Camp Lejeune Environmental Conservation Branch Head summarizing his observations made in his review of Dr. Bruggeman's July 27, 2010 report.

10/15/2010 – the MCB Camp Lejeune Environmental Conservation Branch Head sent an e-mail to the Service RCW Recovery Coordinator clarifying the understanding "that reduction of the MCB Camp Lejeune RCW goal concurrent with a signed agreement with [the NCWRC] and/or Everett Creek/Allen Properties would not be associated with a particular take, and would not substitute for Sec 7 for any proposed take."

10/28/2010 – MCB Camp Lejeune and Raleigh Field Office personnel met with Dr. Doug Bruggeman prior to the Onslow Bight Conservation Forum meeting held at the North Carolina Coastal Federation office. The concept developing the way ahead by putting together a team to participate in a multi-day working session was discussed and agreed to by all concerned.

11/08/2010 – the Field Supervisor, Raleigh Field Office sent an e-mail the Environmental Conservation Branch Head proposing a 2-day meeting between Service, MCB Camp Lejeune and GMI staff to "…hammer out the framework for the RCW system." The proposed meeting dates were January 12-13 or 13-14, 2011. MCB Camp Lejeune responded and suggested January 12-13, 2011.

12/21/2010 – the Service provided its response to MCB Camp Lejeune's September 28, 2010 letter. The Service's letter expressed confidence that if the appropriate management was exercised, RCW groups established on the Stone Creek Game Lands and the Everett Creek and Allen Tracts would support the CNCPC population but also listed a series of conditions that would need to be met to ensure USMC retained recovery credit for establishment of active clusters on these properties.

01/11/2011 through 01/12/2011 – by exchange of e-mail MCB Camp Lejeune, GMI, and the Service agreed to postpone the 2-day meeting until a later date. The new dates selected were February 3 and 4, 2011.

02/03/2011 through 02/04/2011 – the Service Raleigh Field Office hosted a 2-day meeting with MCB Camp Lejeune, GMI, and Service staff to work out the details of a program that would promote RCW recovery and help MCB Camp Lejeune meet its military mission

requirements. The process roughed out during the meeting included the development of a cooperatively-prepared combined biological assessment/biological opinion (BO) to streamline Section 7 consultation. GMI agreed to establish and maintain SharePoint website to enable team members to upload and access components of the draft consultation documents.

1.4 RED-COCKADED WOODPECKER CONSERVATION STRATEGY

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

The historical range of the RCW extended along the southeastern Piedmont and Coastal Plain from New Jersey to Texas and inland as far north as Missouri and west to Oklahoma. Approximately 3 percent of the historical range of the RCW is currently estimated to remain, occupying fragmented habitat from Virginia to Texas. The RCW is considered Imperiled (S2) in North Carolina, South Carolina, Georgia, Florida, Alabama, Louisiana, Arkansas, and Texas and Critically Imperiled (S1) in Virginia, Mississippi, and Oklahoma. It is Possibly Extirpated (SH) in Maryland and Presumed Extirpated (SX) in Kentucky, Tennessee, and Missouri. The RCW was most recently globally ranked as Vulnerable (G3) (NatureServe 2012).

The RCW Recovery Plan (USFWS 2003) states that 14,068 RCWs currently form 5,627 known active clusters across 11 states. In the early 2000s, 1,296 known active clusters occurred on private land in 11 states (Costa and Walker 1995; USFWS unpublished data; USFWS 2003), 631 active clusters occurred on state-owned properties in 7 states, and 3,698 active clusters occupied federally owned properties in 9 states (USFWS 2003; USFWS unpublished data). In the mid-1990s, approximately 50 percent of known RCW were grouped within the six largest known populations found in the Apalachicola NF (Florida), North Carolina Sandhills (NCSH), Francis Marion NF (South Carolina), Kisatchie NF (Louisiana), Eglin Air Force Base and Blackwater State Forest (Florida), and Red Hills hunting plantations in southern Georgia (James 1995; NatureServe 2012).

Recovery criteria in the RCW Recovery Plan (USFWS 2003) have been formulated on the basis of 11 recovery units delineated by ecoregions. Populations required for recovery are distributed among recovery units to ensure the representation of broad geographic, ecological, and genetic variation in the species. 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. Each recovery population is at least partially on designated federal, state, or private properties for management.

The 13 primary core populations consist of at least 350 potential breeding groups (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, inbreeding depression, and catastrophes. 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 active clusters in each support population.

1.4.1 Life History

The RCW is unique in that it is the only North American woodpecker that exclusively excavates its cavities for roosting and nesting in living pines. It is a territorial, non-migratory, cooperative breeding species (Lennartz et al. 1987; Walters et al. 1988). 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 the fungus and typically required for cavity excavation is not generally present in longleaf pine until 90 to 100 years of age (Clark 1992a, 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 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.

RCWs 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 classifies them as single bird groups.

RCWs have large home ranges relative to their body size. RCWs tend to forage within 0.5 miles of their cluster. A 0.5-mile radius circle around a cluster center encompassed an average of 91 percent of the actual home ranges of RCW groups in a North Carolina study (Convery and

Walters 2003). RCW groups forage with 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 trees resource availability (Conner et al. 2001; USFWS 2003).

Each RCW group defends its home range from adjacent groups (Hooper et al. 1982; Ligon 1970). The defended territory includes habitat used for cavity trees and foraging. RCWs feed mostly on a variety of arthropods, particularly ants and wood roaches, by foraging predominantly on and under the bark of larger and older living pines (Hooper 1996; Hanula and Franzreb 1998). Group members forage together each day in pairs in their territory. 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.

Approximately 90 percent of PBGs 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 to 4 eggs in the cavity occupied by an 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. Older and more experienced breeders have greater reproductive success (i.e., 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. Re-nesting rates are geographically and annually variable. In good years, up to 30 percent of breeding groups will re-nest. Productivity of the second nest is lower.

Juvenile males remain in their natal territory or disperse. Those remaining become helpers or, if the breeding male dies before the next breeding season, the male juvenile becomes a breeder. 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, and 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 breeder with a different male (Walters et al. 1988; Daniels and Walters 2000).

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 (Walters et al. 1988). 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 (i.e., 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.

1.4.2 Population Dynamics

RCW population size during a given year is the number of surviving adults plus the number of surviving offspring produced and the number of immigrants to the population 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 upon dispersal by other RCWs in their group. 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.

1.4.3 Population Size

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 occupying a particular geographic area or 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 to other groups in which they may compete for breeding vacancies. Dispersing juvenile and helper males rarely move and assume breeding vacancies at clusters located more than 2 miles from their natal site at North Carolina study areas (Daniels 1997; Walters et al. 1988). Juvenile females from the same study areas are capable of longer forays, becoming breeders in clusters up to 3.7 miles away (Walters et al. 2008). In western Florida, from a study with a smaller number of observations, adults disperse an average distance of 1.1 miles, juvenile females 2.0 miles, and juvenile males 5.0 miles (Hardesty et al. 1997); thus, the spatial structure and distribution of groups are crucial factors defining a demographically functional RCW population and its size.

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, 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 do 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 of 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 to determine the number and composition of groups. The proportion of PBGs and single-male groups in a sample is extrapolated to find the total number of active clusters and an estimate of the total number of PBGs and single-male groups.

RCW populations under natural conditions increase in size 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 new group formation rates 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 immigrant male (Conner et al. 2001). Annual budding rates are low, from 0.6 to 2.1 percent.

1.4.4 Population Response to Habitat Quality

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 a sufficient age and size for cavities and foraging.

The majority of 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 at the periphery of the longleaf pine ecosystem; however, variation among forest ecosystems is not known to significantly alter RCW population

demographics or dynamics under natural conditions. But, the variation in habitat quality and quantity can be associated to some extent with the structural characteristics of 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 sandy soils 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, which results in slower pine growth rates than at more productive mesic sites and community types.

RCW home range size has been directly correlated to variation in the productivity of pine stands. Home range size has been related to the areas of suitable habitat within 1.24 miles of the cluster, pine basal area, pine density, pine density greater than 9.84 inches diameter breast height (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. 2000a, 2002a). Larger areas of low quality habitat are generally required and smaller areas are sufficient in high quality habitat.

In small habitat patches, patches within stands, and stands within a landscape, RCWs selectively forage in their home ranges on larger and older pines more frequently than on younger and smaller trees, although more smaller trees are available (Zwicker and Walters 1999; Walters et al. 2002a). Overall, RCWs preferentially use pine 12 to 20 inches dbh, prefer trees greater than 20 inches dbh, but 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 are available (Walters et al. 2000a).

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 herbaceous plant ground cover. RCW group size, fecundity, or both is positively related to a specific and relatively open arrangement of old and large pine and an increase in 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 1991a; Rudolph and Conner 1994; Hardesty et al. 1997; Engstrom and Sanders 1997; James et al. 1997, 2001; Walters et al. 2002a). Group size affects productivity because the number of fledglings increases with group size, generally with an average of two fledglings in groups of 4 to 5 adults and helpers, and one 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. 2002a). 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 forage habitat consists of an open fire-maintained pine forest, with no or a sparse midstory, low densities of small pine (<10 inches dbh), moderate densities of medium-sized (10 to 14 inches

dbh) and large (>14 inches dbh) pine, low and high densities of old growth pine, and well-developed herbaceous plant ground cover (James et al. 2001; Walters et al. 2002a). Understanding the contribution of old growth to habitat quality has been limited by the rarity of this habitat, although RCWs from the old-growth tracts 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.

1.4.5 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 great magnitude over a short period of time. 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).

1.4.6 Demographic Stochasticity

With the added effects of demographic stochasticity, Letcher et al. (1998) found that small RCW populations with 49 highly aggregated clusters were stable over 100 years, and smaller populations of 25 highly aggregated clusters were highly persistent for about 60 years. Highly aggregated clusters share common territorial boundaries. Even smaller, highly aggregated populations of 20 and 10 clusters had good persistence for 20 years, although annual geometric population growth rates were less than 1.0 and projected to slowly decline with time (Crowder et al. 1998). Highly aggregated populations of 49 clusters were more stable than minimally aggregated populations of 169 or 250 clusters. Populations with less than 100 clusters that were not highly aggregated declined and were not viable. Regardless of the aggregation or clumping

of the modeled populations in their study (Letcher et al. 1998), populations of 500 clusters were viable and moderately aggregated clusters of 250 were stable.

The density of populations with 49, 100, and 169 clusters 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 NF (one group per 3,873 acres), MCB Camp Lejeune (one group per 1,898 acres), and NCSH (one 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 Carrol 1994); however, spatial structure strongly affects viability of RCW populations with fewer than 50 clusters under stochastic demographic fluctuations. The strong persistence of highly aggregated RCW populations with less than 50 clusters reflects the demographic effect of a non-breeding 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. 2002b).

1.4.7 Environmental Stochasticity

RCW environmental stochasticity is represented by the variation in demographic rates and group structure among years. The RCW individual-based, spatially-explicit population model (IB-SEPM) with demographic and environmental stochasticity (Walters et al. 2002b) 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. (2002b) considered most representative of the majority of current RCW populations. Two higher levels of density were investigated, while controlling for the effects of population size.

Overall, Walters et al. (2002b) 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 non breeding class of helpers in the RCW cooperative breeding system had a buffering effect on breeder mortality and loss of breeding groups.

1.4.8 Inbreeding

Daniels et al. (2000) used an RCW IB-SEPM to assess potential inbreeding effects with demographic and environmental stochasticity on 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 that caused reduced egg hatching success and fledgling survival; however, the IB-SEPM assessment of potential inbreeding effects

did not directly incorporate reductions in RCW fitness due to demographic variables. Instead, Daniels et al. (2000) computed coefficients of kinship for each breeding pair (i.e., inbreeding coefficient of offspring) and mean kinship of RCW pairs to identify pairs that were unrelated, moderately related, and closely related. Kinship pedigree analyses were 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 IB-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 more 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.

1.4.9 Catastrophes

Hurricanes, tornados, 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. Within a 70-mile radius of MCB Camp Lejeune which encompasses the entire Onslow Bight landscape 11 hurricanes have occurred since 1981 (NOAA 2012; NCSU 2011; Table 1-1).

Table 1-1. Hurricane Occurrences within the Project Area from 1981 – 2011.

Year	Name	Category	Wind (knots)	Distance (miles)
1984	Hurricane Diana	4	115	36.00
1986	Hurricane Charley	1	65	48.25
1996	Hurricane Bertha	1	65	28.28
1996	Hurricane Fran	3	100	60.00
1998	Hurricane Bonnie	2	85	10.31
1999	Hurricane Floyd	2	90	4.20
2003	Hurricane Isabel	2	85	65.64
2004	Hurricane Alex	2	85	64.26
2005	Hurricane Ophelia	1	75	41.02
2011	Hurricane Irene	1	75	45.88

Data from National Oceanic and Atmospheric Administration (NOAA 2012) and State Climate Office of North Carolina (NCSU 2011)

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 NF, reducing the estimated pre-storm population of 477 active clusters to 277 clusters with at least one remaining cavity tree (Hooper et al. 1991; Watson et al. 1994). The Francis Marion population, at that time, was one of the largest. Coastal populations, particularly small populations, are highly vulnerable while the most inland populations are at least risk. RCW populations in the Croatan NF (North Carolina), Francis Marion NF (South Carolina), Apalachicola NF (Florida), DeSoto NF (Mississippi), Eglin Air Force Base (Florida), and Conecuh NF (Alabama) 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. 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.

1.4.10 Recovery Plan Efforts

The ultimate recovery goal is species viability. This goal is represented by delisting. Once delisting criteria are met, the size, number, and distribution of populations will be sufficient to counteract threats of demographic, environmental, genetic, and catastrophic stochastic events, thereby maintaining long-term viability for the species as defined by current understanding of these processes. Regions and habitat types currently occupied by the species will be represented to the best of our ability, given habitat limitations.

As indicated previously, according to the RCW Recovery Plan (USFWS 2003), 14,068 RCWs form 5,627 known active clusters across eleven states. In the early 2000s, 1,296 known active clusters occurred on private land in 11 states (Costa and Walker 1995; USFWS unpublished data; USFWS 2003), 631 active clusters occurred on state-owned properties in 7 states, and 3,698 active clusters occupied federally owned properties in 9 states (USFWS 2003; USFWS unpublished data).

The number of active clusters, their distribution, varying land ownership, habitat fragmentation, increased urban pressures, and other management issues will require novel and imaginative tools and strategies if the ultimate recovery goal is to be met for RCWs. Identifying programs, like the RASP, that can work within the recovery criteria outlined in the RCW Recovery Plan (USFWS 2003) and expanding on them by improving ecological function within primary and secondary populations is both timely and vital.

1.5 RED-COCKADED WOODPECKER RECOVERY AND SUSTAINMENT PROGRAM

1.5.1 Purpose and Scope

This PBA is intended to establish the RASP as a program which contributes to the recovery of RCWs in the CNCPC population and their associated habitat. The focus of the PBA is to fulfill the requirements of the ESA, and provide consistency in the assessment, establishment, and management of properties to grow new RCW groups. Additionally, the PBA broadly defines or assigns roles to the agencies and other participants in the RASP; however, these roles may vary to some degree in response to the circumstances surrounding particular properties.

The ultimate goal of the ESA, as amended (16 USC 1531 et seq.), is the recovery of endangered and threatened species and the ecosystems on which they depend. In administering the recovery provisions of ESA, the USFWS collaborates with many partners, including federal, state, and local agencies, Tribal governments, conservation organizations, the business community, and private landowners. In most cases, administering the recovery provisions, planning, and implementation depend in part on creative processes and agreements with federal partners as well as other non-federal partners in community-based recovery efforts. Examples of innovative conservation tools under the ESA include Safe Harbor Agreements, Habitat Conservation Plans, Recovery Permits, and conservation banks. The ultimate success of conservation and recovery of endangered and threatened species depends on a variety of innovations, such as these, that may be used in concert with one another or alone. The RASP has been designed to complement these conservation tools using existing authorities and any new authorities that might be granted by Congress.

The PBA will provide a detailed methodology for evaluation and selection of properties which may be of conservation benefit to RCWs in the CNCPC population. The RASP may complement mitigation tools and conservation programs currently available, such as conservation banking, and in some cases, provide linkage between these programs (e.g., agreements that protect properties between Safe Harbor Agreements).

The RASP is a specific program established to provide recovery actions on federal, state, and non-federal lands for RCWs within the Project Area while creating conservation measures that MCB Camp Lejeune may use to reduce their recovery goal. That is, MCB Camp Lejeune will use its authorities to work cooperatively with the USFWS to conserve and enhance properties that currently benefit or have the potential to benefit the recovery of RCWs in the CNCPC population. These conservation measures will be evaluated for their benefit to the ecological function of the CNCPC population and recovery goal of 350 PBGs (i.e., defined by the RCW Recovery Plan [USFWS 2003]). As benefits are cooperatively defined by the USFWS and MCB Camp Lejeune, the recovery goal of the base will be measurably reduced.

Conversely, as long as the overall system provides a benefit to the conservation of RCW, as required by the RCW Recovery Plan (USFWS 2003), this system is fundamentally similar in principle to conservation banking and habitat conservation plans that are currently being authorized by the USFWS.

Cooperatively, these authorities will allow USFWS and MCB Camp Lejeune to conserve and protect large parcels of federal, state, and non-federal land that can assist in the recovery of RCWs in the CNCPC population and their habitats. The recovery actions represented by the RASP provide both parties a concrete and timely conservation tool that will have a long-term benefit to the CNCPC population. Projects may include federal, state, and non-federal properties and may include agreements, contracts, and real estate transactions.

1.5.2 Authorities

The ESA provides the framework for this guidance. The ESA's stated purposes include providing "… a means whereby the ecosystems upon which [listed] species depend may be conserved …" and "… a program for the conservation of such [listed] species…." Under Section 3 of the ESA, conservation is defined as using "…all methods and procedures which are necessary to bring any [listed] species to the point at which the measures provided pursuant to [the ESA] are no longer necessary." Within the context of this guidance, these definitions help determine and evaluate appropriate conservation measures and benefits; further, recovery planning is addressed under Section 4(f) of the ESA, where "provisions for the development of and survival of [listed] species" are provided. A recovery plan is one of the most important tools to ensure sound decision-making throughout the recovery process.

Section 7(a)(1) of the ESA requires that all federal agencies "…in consultation with and with the assistance of the [Service], utilize their authorities in furtherance of the purposes of [the ESA] by carrying out programs for the conservation of [listed species]." There is broad discretion for federal agencies to determine the appropriate methods for implementation of Section 7(a)(1). One possible method for agencies to utilize their authorities for the conservation of the species is through the RASP.

Establishing a program, such as the RASP, that results in conservation benefit to RCW would contribute to that species' recovery. That is, the status of the target species will improve because, overall, a conservation benefit will occur as current and potential RCW habitat is protected in perpetuity for the CNCPC population; however, as each individual property is evaluated for conservation benefit to the CNCPC population, MCB Camp Lejeune and the USFWS will have to balance their authorities, statutory obligations, and missions to determine if this policy is appropriate or viable for their purposes.

As a conservation tool, the RASP will allow MCB Camp Lejeune and the USFWS to use their authorities for the conservation of RCWs. MCB Camp Lejeune is authorized under Title 10,

USC Section 2684a, "*Agreements to Limit Encroachments and Other Constraints on Military Training, Testing and Operations*," to enter into agreements with states, their political subdivisions, and private conservators to acquire real estate interests "…in the vicinity of, or ecologically related to, a military installation or military airspace…" for the purposes of: 1) limiting development or property uses that are incompatible with the installation's mission, or 2) preserving habitat off-base to eliminate or relieve current or anticipated environmental restrictions on base. The law also allows for payment of natural resources management costs "if the Secretary concerned determines that there is a demonstrated need to preserve or restore habitat for the purpose described in Subsection (a)(2). and that such payments (A) may be paid in a lump sum and include an amount intended to cover the future costs of natural resource management and monitoring and enforcement; and (B) may be placed by the eligible entity in an interest-bearing account, and any interest shall be applied for the same purposes as the principal".

In addition to 10 USC 2684a, recent changes to the Sikes Act (16 USC 670c) allow the military to "enter into cooperative agreements with states, local governments, nongovernmental organizations, and individuals to provide for…The maintenance and improvement of natural resources located off of a Department of Defense (DoD) installation if the purpose of the cooperative agreement is to relieve or eliminate current or anticipated challenges that could restrict, impede, or otherwise interfere with, whether directly or indirectly, current or anticipated military activities."

Further authorities found in 10 USC 2694c allow the Marine Corps to make payments into Conservation Banking or "In-Lieu Fee" programs for the purpose of facilitating one or more of the following activities: (1) Military testing, operations, training, or other military activity. (2) Military construction.

Authorities for contracts, grants and agreements provided to all Executive Branch agencies of the federal government may also be used as vehicles to fund and implement projects and activities associated with the RASP.

1.5.3 Goals and Objectives

The goal of the RASP is to enhance the ability of MCB Camp Lejeune and the USFWS to promote the recovery of the CNCPC population of RCW and allow MCB Camp Lejeune to reduce its on-base recovery goal. Objectives are (1) to promote recovery of the RCW. (2) to reduce the MCB Camp Lejeune RCW recovery goal, (3) to increase the flexibility of MCB Camp Lejeune to accomplish their current and future training requirements. and (4) to promote effective federal/non-federal partnerships for species recovery. The intent of the RASP is to work within the general guidelines of the current RCW Recovery Plan (USFWS 2003).

1.5.4 Recovery and Sustainment Program Methodology

The RASP can be described as: (1) a program that assesses, establishes, and ensures management of federal, state, and non-federal properties within the range of the CNCPC population through agreements, contracts, and real estate transactions, which would accomplish recovery tasks and have a conservation benefit for RCWs in the geographic region; and (2) a subsequent federal action, which will allow the reduction of the MCB Camp Lejeune RCW recovery goal. It should be noted that authorization of a reduction in the MCB Camp Lejeune RCW recovery goal does not authorize the "take" of RCW groups on MCB Camp Lejeune. Impacts to endangered species, including RCW will continue to be addressed in accordance with ESA Section 7 regulations; however, the reduction in recovery goal does affirm that the RCW groups established off-base will contribute to the recovery goal of the CNCPC population.

MCB Camp Lejeune may choose to employ the RASP and other conservation tools to accomplish recovery tasks and ensure the current and future training needs of its service men/women are sustained. Although MCB Camp Lejeune with appropriate authorities may also choose to offset future proposed actions by using a conservation bank or employing other mitigation or conservation measures, MCB Camp Lejeune may choose to implement this program as well. The RASP works within the existing framework of the ESA and its implementing regulations. This PBA is intended to assist in outlining the planning and implementation of the RASP. Because no two properties are expected to be identical, this programmatic guidance serves to address the fundamental RASP process that would apply to all situations.

The general methodology of the RASP includes:

1) Phase I: Information Gathering and Preliminary Analyses
2) Phase II: Analysis of the Biological Function of an Identified Property;
    a. A geospatial landscape model and two IB-SEPMs will be utilized to assess conservation benefit of the property
3) Phase III: USFWS Notification and Determination of Functionality;
4) Phase IV: Formulation of Agreements to Protect RCW Habitat in Perpetuity (between MCB Camp Lejeune and the state and non-federal property owner); and
5) Phase V: USFWS Final Approval of Reduction in Recovery Goal for MCB Camp Lejeune.

1.5.5 Anticipated Benefits to Coastal North Carolina Primary Core Population

Species viability is a product of population viability and therefore depends on population structure. The Recovery Plan strategy stands on a combination of maintaining several identified

demographically independent viable populations with a number of smaller interacting populations within recovery units to support genetic viability.

The methods and approaches developed for the RASP will be useful to help guide the USFWS, state, and federal agencies and non-governmental efforts to achieve recovery of the CNCPC population. Population modeling techniques being developed and tested in cooperation with research scientists will help reduce uncertainty in projecting the species response to proposed efforts associated with the RASP. These same techniques can be used to help improve the ability to predict impacts to RCW resulting from construction projects or other activities for which Section 7 consultations must be conducted.

Implementing the RASP would expand the geographic area within which management for RCW conservation will be practiced. In execution, the RASP has the potential to expand and/or change the recovery landscape in a way that contributes to the overall strengthening and stabilization of extant and potential future RCW subpopulations comprising the CNCPC population. This process provides a vehicle for USMC to achieve its Section 7(a)(1) responsibilities and potentially accelerate species recovery. The RASP would bring the best available science to bear on the federal agency's ability to effectively promote RCW recovery within the CNCPC population. The RASP would provide the USFWS and MCB Camp Lejeune with an established procedure for reviewing proposed accrual of potentially suitable acreage to habitat currently being managed for RCW conservation, in support of the recovery population. This advanced assessment system will provide a yardstick by which to measure changes in demographic function based on the known biological needs of the species.

The recovery plan cites examples of success on federal lands where management strategies based on maintaining and creating suitable territories indeed increase RCW populations. Conservation actions related to the RASP have the potential to benefit existing groups and support population expansion adjacent to the portions of the current population which has otherwise limited prospects for growth due to the limited amount of neighboring land under federal ownership. The USFWS recognizes the role that private lands play in supporting RCW recovery; however, although the ESA prohibits take on private lands, there is no requirement for individuals to affirmatively contribute to species recovery. The intent of the USFWS's private lands strategy is to promote flexibility and encourage cooperation between private citizens and the USFWS. The USFWS's Private Lands Guidelines (Recovery Plan, Appendix 5) reflect the importance given to forest structure including desired future conditions that encourage retention of larger pines, lower densities of smaller pines, strict control of hardwoods and the importance of native plants in the herbaceous layer that are exhibited in the Recovery Standard Guidelines; however, the Private Lands Guidelines are a lower standard in terms of the amount of acreage that should be retained per group as well as the way larger diameter, mature pine trees are accounted for and conserved. The Private Lands Guidelines express the minimum acreage of appropriately-stocked pine forest needed to sustain a single breeding group of RCWs. Guidance for managing the most important

foraging and nesting resource—the larger, older pine trees is limited to establishing the minimum basal area per acre for pines ≥10 inches dbh, whereas the Recovery Standard directs forest management to further regulate the number and density of pines between 10 inches and 14 inches dbh and to manage for an increase in the stocking and distribution of pines ≥14 inches dbh.

Prospectively, as the RASP achieves mutual conservation and land management success, landowners within the project action area may become more willing to consider active RCW conservation on their properties. The potential for private entities to derive income for managing their properties as part of the recovery landscape may reduce or offset disincentives often associated with endangered species on private lands. The RASP may generate the interest of private landowners in the statewide RCW Safe Harbor Program administered by the North Carolina Wildlife Resources Commission. The RASP would establish basic habitat criteria that must be attained and retained to ensure that new territories identified off base will be managed in accordance with the same standards as those on MCB Camp Lejeune (e.g., the Recovery Standard). Application of the rules established in the RASP will ensure that benefits to the species resulting from the extension of Recovery Standard management off the installation are maximized.

1.5.6 Anticipated Benefits to Marine Corps Base Camp Lejeune Mission

This program will benefit the MCB Camp Lejeune mission by allowing for greater flexibility in the current and future training requirements and their possible impacts to RCWs. By simultaneously reducing the recovery goal on MCB Camp Lejeune, increasing the environmental baseline for RCW off-base, and potentially improving the function of the CNCPC population, this program will greatly reduce the likelihood that a future project on MCB Camp Lejeune will result in a jeopardy BO for impacts to RCW.

The most substantial benefit to MCB Camp Lejeune is the reduction in the Base's RCW recovery goal. The current goal of 173 active clusters will require habitat management on most of the available land on MCB Camp Lejeune, excluding the Greater Sandy Run Area (GSRA). While infantry training activities can still take place in RCW foraging habitat, the available space for projects that require tree cutting, including future ranges, landing zones, and armor mechanized maneuver areas, has diminished to the point that the next large scale project could result in the inability of MCB Camp Lejeune to meet its recovery goal. The RASP will assist MCB Camp Lejeune in meeting its recovery goal while developing capabilities to support training activities such as development of the Combined Arms Amphibious and Assault Course.

In addition to the benefits associated with reducing the RCW recovery goal, this program will benefit the MCB Camp Lejeune mission by increasing the environmental baseline for RCW when consulting with the USFWS on projects that may impact RCW. The environmental

baseline will be increased by the number of clusters or potential clusters on off-base properties that are shown to function as part of the CNCPC population. This increased environmental baseline for RCW will reduce the likelihood of a jeopardy BO on future projects.

The RASP has the potential to greatly increase the flexibility of MCB Camp Lejeune to support future training missions. The program will result in a reduced RCW recovery goal on MCB Camp Lejeune while increasing the environmental baseline for RCW and potentially strengthening the biological function of the CNCPC population.

1.6 REDUCTION OF MARINE CORPS BASE CAMP LEJEUNE RED-COCKADED WOODPECKER RECOVERY GOAL

In 1999, MCB Camp Lejeune coordinated with the USFWS to develop the Mission-Compatible, Long-Range RCW Management Plan (USMC 1999). The plan was endorsed in December 1999 with implementation initiated in 2000. The 1999 RCW Plan established a mission-compatible goal of 173 active RCW clusters, outlined management strategies and accounted for incidental take. The 2007 MCB Camp Lejeune Integrated Natural Resource Management Plan (INRMP) (USMC 2006) and the associated BO established a system for reduction of restrictions on military training activities in RCW habitat.

The RASP allows MCB Camp Lejeune and the USFWS to work cooperatively to enhance the recovery of RCWs while providing MCB Camp Lejeune with an adaptive management tool that will ensure that current and future training requirements can be met. The RASP will allow a reduction in the recovery goal at MCB Camp Lejeune for any property that is considered to provide biological function for the CNCPC population, which includes Croatan NF and Holly Shelter. Reduction in the recovery goal will be subject to the following general conditions/processes:

1) MCB Camp Lejeune will continue to manage habitat on the installation for RCW. The installation will not abandon management of base property that can support RCW unless approved to do so via Section 7 consultation.

2) The RASP does not establish a credit/debit process. The ESA Section 7 process will be used for projects on base that may affect RCW.

3) MCB Camp Lejeune and the USFWS agree that during the Section 7 evaluation of a proposed action, all protected and managed habitat and clusters within the CNCPC population can be used in the determination of jeopardy/non-jeopardy. Projects that expand the “baseline” within the CNCPC population will benefit MCB Camp Lejeune by reducing the importance of MCB Camp Lejeune clusters to the overall population. Recently developed computer population modeling techniques including the Decision Support System (DSS) and LEA/POM are tools available for helping to evaluate the affects of a project on factors such as RCW abundance and persistence, genetic drift, and

inbreeding. These tools will be utilized as necessary to ensure that "best available science" is used to inform decisions regarding potential impacts to RCW.

4) The USFWS will give conditional approval for inclusion of properties in the RASP, pending an agreement with the landowner for preservation and management for RCW on the property in question.

5) Financial assurances, federal remedies, and management actions must be in place for properties being considered for acquisition and/or management under the RASP.

6) The USFWS final approval of a RASP property is provided when an agreement is reached with the landowner that meets the requirements of this programmatic agreement.

1.6.1 Section 7 Consultation Process for the Recovery and Sustainment Program

The ESA requires action agencies to provide the best scientific and commercial data available regarding the impact of a proposed project on listed species or designated critical habitat. In the past 20 years, a considerable amount of information pertaining to RCW populations in the project area has been accumulated. This biological dataset has proved to be essential to the Section 7 consultation process between the Marine Corps and the USFWS for numerous projects involving training range development and RCW conservation; however, the scope of impacts from these projects has been relatively limited. Both attainment of recovery objectives for the RCW and consideration of impacts to RCWs anticipated from larger scale range development require the Marine Corps and the USFWS to have the ability to investigate the processes that act on RCWs at the population level. The RASP provides a scientifically rigorous tool that will enable us to envision the behavior of the metapopulations within the recovery unit and sufficiently assess project impacts.

The purpose of the RASP is to guide and support all of the federal agency's Section 7 responsibilities. The program would enable MCB Camp Lejeune to enlarge the landscape within which the Marine Corps, federal, state, and private partners can pursue place-based RCW conservation that will demonstrably improve the recovery status of the species within the CNCPC population. The RASP spells out the scientific process by which the federal agency "…carr[ies] out programs for the conservation of species listed pursuant to the [ESA]."

In compliance with Section 7(a)(1) of the ESA, the RASP would ensure that the recovery standard (USFWS 2003) would be applied to guide management of all properties dedicated to supporting recruitment clusters and associated foraging habitat. The recovery standard is a list of criteria used to direct habitat management for RCWs toward desired future conditions, including optimum densities and distribution of the largest pine trees in a stand's overstory, lower stocking of younger and smaller pine trees and sparse presence of hardwoods. The selection of pine stocking parameters is based in part on site productivity. The presence of a native, fire-adapted herbaceous layer including naturally occurring bunchgrasses is prioritized in the recovery

standard criteria. The use of prescribed fire to maintain ecological function is essential. Application of the recovery standard on lands outside of installation boundaries would promote the generation and expansion of future nesting habitat and good quality foraging habitat in a manner that enhances population growth and long-term viability.

Implementation of the RASP has the potential to grow RCW populations within the recovery unit in a variety of stable, self-sustainable configurations. Prospectively, the RASP would also provide flexibility within MCBCL's land base to develop military training ranges and other facilities that require the elimination of current and future foraging and nesting habitat. The RASP will establish the means by which the action agency and the USFWS maintain the essential information necessary to describe and keep track of the environmental baseline.

To promote achievement of recovery objectives activities such as prescribed burning, cavity provisioning, and translocations of RCWs into recruitment territories off base will be necessary. The net results of these activities would promote the growth and stability of recipient RCW subpopulations; however, RCWs have been known to die in artificial cavities by getting caught in sap leaks caused by either the birds or tools used to create the cavity (e.g., drill or saw) penetrating through the heartwood into the sapwood. Cavity provisioning and the trans-locating of RCWs will only be conducted by qualified personnel who hold the necessary section 10 recovery permits.

Cluster management including insertion of cavity boxes, cavity drilling, and installation of cavity restrictors has been practiced in most managed RCW populations. The circumstances under which RCWs have been killed by using artificial or restricted cavities have been well documented. Permitted technicians are trained and aware of the methods for precluding accidental loss of birds that use these cavities; therefore, incidental take associated with cavity provisioning and cluster management is expected to be very low. Prescribed burning is necessary to create and maintain characteristics that define good quality foraging habitat. The techniques used on Camp Lejeune to protect cavity trees from prescribed burning and wildland fire (fireproofing) will also be practiced on the acquired properties. The loss of cavity trees associated with implementing the prescribed fire regimen on the RASP properties is expected to be similar to that experienced on the installation.

2.0 ENVIRONMENTAL BASELINE

2.1 PROJECT AREA DESCRIPTION

The Project Area consists of 13 counties and covers approximately 250,000 square kilometers and includes portions of the Atlantic Coastal Flatwoods Section, the Coastal Plains, and Flatwoods Lower Section of the U.S. Department of Agriculture (USDA) Forest Service's Ecological Regions Map (Keys et al. 1995). Relief in the region is minimal, peaking at 50 meters with most of the area being less than 15 meters above sea level. The northeastern corner of the project area was partially submerged in the post-glacial period and is referred to as the embayed region (Robinson 1979). To the south, marine terraces are considered to be a region of emergence, making swamps less common and creating conditions for defined river valleys. The vegetation represents a complex mosaic of wetland and upland plant communities, many of which are fire dependent. Like most of the Southeastern U.S., the southern pine forests of the Project Area today are very different from pre-colonial communities not only in extent, but also in species composition, age, and structure (Ware et al. 1993; Noel et al. 1998). Original pine forests were old, open, and contained a structure of two layers: canopy and diverse herbaceous groundcover. These forests were dominated by longleaf pine in the coastal plain. In contrast, much of current forest in this region is young, dense, and dominated by loblolly pine, with a substantial hardwood component and little or no herbaceous groundcover (Ware et al. 1993; Noel et al. 1998).

Original longleaf communities in the Project Area were first heavily impacted by exploitation for naval stores and then virtually eliminated by widespread logging and the subsequent reproductive failure of longleaf pine (Frost 1993; Ware et al. 1993). Naval stores industries harvested pine resin for the production of tar, pitch, and turpentine—commodities in high demand during colonial times. Pine woodlands were logged for lumber and conversion to agricultural fields. Impacts to easily accessible areas began with the arrival of Europeans, but technological developments of the 1800s, such as the copper still, steam power, and especially railroads, dramatically increased the rate and area of loss (Frost 1993). In the late 1800s logging operations moved to the previously inaccessible interior forests of longleaf, shortleaf, and loblolly pines. For over a decade these operations removed a reported 3 to 4 billion board feet per year (Frost 1993); an estimated 13 billion board feet of longleaf was extracted in 1907 alone (Wahlenburg 1946; Landers et al. 1995). This especially intense period of logging from 1870 to 1930 resulted in the loss of nearly all of the remaining old growth forest in the southeastern U.S. (Frost 1993; Martin and Boyce 1993; Conner et al. 2001).

Additionally, suppression of fire increased with the rise of pine plantations, a land use that began in the 1930s and 1940s and continues to increase today (Martin and Boyce 1993; Stout and Marion 1993; Ware et al. 1993). Historically, pre-colonial fire frequencies in the southeast have

been estimated at 1 to 3 years for the Atlantic coastal plains (Stout and Marion 1993; Ware et al. 1993; Frost 1998). Fire frequency increases with size of fire compartments, and natural firebreaks in the southeastern coastal plains were rare (Ware et al. 1993; Frost 1998); however, active fire suppression began to be institutionalized in the southeastern U.S. between 1910 and 1930 (Frost 1993; Ware et al. 1993).

Fire suppression has severe and numerous impacts on southern pine ecosystems, including changes in tree species composition and forest structure. Longleaf pine cannot reproduce without access to the mineral soil, and will be replaced under fire suppression by other species of pines and hardwoods. The structure of the forest changes from two layers, a canopy and a diverse groundcover, to a multi-layered midstory and canopy with little or no groundcover. With increasing hardwood midstory, arthropod communities change in species abundance, species composition, and distribution on the substrate (Collins et al. 2002; Provencher et al. 2001a). RCWs are directly and adversely affected by each of these changes.

These primary threats, among others (e.g., economic forest management practices and urbanization), to species viability for RCWs in the Project Area, in all have the same basic cause: lack of suitable habitat. RCWs require open mature pine woodlands and savannahs maintained by frequent fire, and there is very little of this habitat remaining (Lennartz et al. 1983; Frost 1993; Simberloff 1993; Ware et al. 1993). On public and private lands, both 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 1991b); (3) lack of foraging habitat of adequate quality (Walters et al. 2000a, 2002a; 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).

2.2 MARINE CORPS BASE CAMP LEJEUNE SITE DESCRIPTION

MCB Camp Lejeune consists of 125,418 acres of land of which approximately 95,000 acres are managed forestland. Portions of MCB Camp Lejeune, such as the G-10 and K-2 impact areas, are used exclusively for military training and are not considered commercial forestland. Pure pine, pure hardwood, and mixed/pine hardwood stands are the dominant forested vegetation types found on MCB Camp Lejeune. Approximately 75 percent of pine acres are loblolly pine, with the remaining pine consisting of longleaf pine (*Pinus palustris*), pond pine (*Pinus serotina*), and planted slash pine (*Pinus elliottii*). Several species of hardwoods are present at MCB Camp Lejeune including black gum (*Nyssa sylvatica*), sweet gum (*Liquidambar styraciflua*), southern red oak (*Quercus falcata*), white oak (*Quercus alba*), red maple (*Acer rubrum*), and yellow

poplar (*Liriondendron tulipifera*). Shrub species composition varies with wetness, but generally consists of wax myrtle (*Myrica cerifera*), blue huckleberry (*Gaylussacia frondosa*), and sparkleberry (*Vaccinium arboretum*). Groundcover species vary with the degree of land disturbance and fire regimes, but can include wiregrass (*Aristida stricta*) in longleaf pine savannas, bracken fern (*Pteridium aquininum*), and bluestems (*Schizachyrium* spp.), as well as more disturbance tolerant species such as greenbriar (*Smilax* spp.) and broomsedge (*Andropogon virginicus*) (USMC 2006).

MCB Camp Lejeune's RCW management practices remain essentially unchanged in the last 12 years. They include guidelines relating to recruitment stands, artificial cavities, cavity restrictors, translocation/augmentation, cluster reconfiguration, vegetation management treatments, prescribed burning use, and southern pine beetle suppression.

To achieve the RCW goal, MCB Camp Lejeune established a method of recruitment site identification, partitioning, provisioning (establishing new clusters), and habitat management. Recruitment sites are identified and assigned a projected provisioning time period based on stand age and proximity to existing clusters. Beneficial silvicultural techniques and prescribed fire are aggressively used to improve habitat while retaining older, more mature trees.

2.3 HOLLY SHELTER STATE GAME LAND SITE DESCRIPTION

Holly Shelter, owned and managed by the NCWRC, consists of about 47,699 acres of land of which almost 3,000 acres of longleaf and 557 acres of other pines is managed forestland. Located south-southwest of MCB Camp Lejeune in Pender County, North Carolina, it is one of the largest and highest quality areas of savanna, flatwoods, and pocosin habitat remaining on the Atlantic Coast (see Figure 1-1). One of the largest peat-filled pocosin basins in the southeastern U.S. is located on Holly Shelter. Pond pine woodland communities dominate the wetland, which comprises approximately 75 percent of the total acreage, although 14 other natural community types have been documented. The site also supports 25 species of rare plants and 19 species of rare animals, including a large population of RCW (LeBlond and Grant, no date).

Vegetation occurring at Holly Shelter is similar to that described for MCB Camp Lejeune. The pond pine communities include pond pine, black gum, sweetgum, red maple, and loblolly-bay (*Gordonia lasianthus*) in the overstory and titi (*Cyrilla racemiflora*), gallberry (*Ilex glabra*), and large gallberry (*Ilex coriacea*) in the shrub layer.

Although Holly Shelter has been intensively managed for RCW over the past 10 to12 years, it is near capacity under current conditions. Management practices should follow recommendations outlined in the RCW Recovery Plan (USFWS 2003) and include monitoring and prescribed fire. Although the number of clusters at Holly Shelter is close to the goal set forth in the RCW Recovery Plan (USFWS 2003), acquisition of surrounding property and longleaf habitat

restoration may allow Holly Shelter to support additional RCW clusters. Holly Shelter remains an important area to support the CNCPC population.

2.4 CROATAN NATIONAL FOREST SITE DESCRIPTION

The Croatan NF, owned and managed by the USDA Forest Service, consists of approximately 161,000 acres of which 70 percent is fire-adapted or fire-dependent forestland (USFS 2012). Located northeast of MCB Camp Lejeune in Carteret, Craven, and Jones counties, it is defined by an abundance of water and consists of pocosins, saltwater estuaries, bogs, hardwood wetlands, longleaf pine, loblolly pine, pond pine, and upland mesic hardwood forests. Croatan NF contains the best and most extensive remaining examples of the tall forms of pond pine communities in the North Carolina Coastal Plain with nearly 90 percent of pond pines approaching old growth condition. The Croatan NF has about 70 percent short interval fire-adapted ecosystems, including about 50 percent pocosin habitat and 16 percent longleaf pine, of which about 5 percent is old growth (Soule 1987).

The Croatan NF was created in 1936 to reforest the land. Loblolly pine was planted in most of the area suitable for upland forests. To prevent catastrophic damage to these forests, fire was suppressed throughout most of the 20th century. In 1989, the Southern Region of the Forest Service developed suggested methods of use and an analysis of the effects of five Coastal Plain/Piedmont vegetation management methods: prescribed fire, mechanical, manual, herbicides, and biological.

Croatan NF management practices reflect the guidelines for RCW recovery. To achieve the RCW goal, Croatan NF established a method of recruitment site identification, partitioning, provisioning (establishing new clusters), and habitat management where conditions will support the management of upland pine (primarily longleaf) for ecological restoration. Current 2011 proposed actions will provide for restoration of the longleaf pine ecosystems of the NF including management for RCW habitat and the general biodiversity associated with longleaf pine forests (USFS 2011). Primary management actions necessary for restoration include thinning, site preparation, seedling planting, and midstory control.

2.5 FEDERALLY PROTECTED SPECIES AFFECTED BY PROPOSED ACTION

This proposed project may affect several federally listed plant species and is likely to affect RCW. Federally endangered plant species that may be affected include:

- Rough-leaved Loosestrife (*Lysimachia asperulaefolia*)
- Pondberry (*Lindera melissifolia*)
- Golden Sedge (*Carex lutea*)

- Cooley's Meadowrue (*Thalictrum cooleyi*)
- American chaffseed (*Schwalbea americana*)

2.5.1 Rough-leaved Loosestrife

Rough-leaved loosestrife was listed as federally endangered in 1987 (USFWS 2011b). It is a perennial herb, erect, with mostly unbranched stems, growing to a height of 12 to 24 inches (NCNHP 2001; USFWS 2011b, 2010). Leaves are bluish-green, strongly triangular, and conspicuously whorled in threes or fours; the name 'rough-leaved' is a misnomer as leaves are mostly smooth in texture (Weakley 2008; USFWS 2011b, 2010). Small, stalked glands are present on most of the plant, especially leaf bases (NCNHP 2001; USFWS 2011b, 2010). Flowers are produced at the top of the stem and are five-parted, yellow, and showy (Weakley 2008; USFWS 2011b, 2010). Flowers bloom from May to June and produce fruits enclosed by rounded capsules (NCNHP 2001).

Rough-leaved loosestrife almost always occurs (under natural conditions) in wetlands (NRCS 2009). Open to partly-open conditions are requisite for desirable habitat and are mainly achieved by fire (USFWS 2011b, 2010). It occurs mostly in ecotones between longleaf pine uplands and pond pine pocosins (Weakley 2008). Other preferred habitat includes low and high pocosins, sandhill seeps, wet pine flatwoods, pine savannas, streamhead pocosins, and poorly drained depressions (USFWS 2011b, 2010). It is also found in disturbed areas such as fire plow lines, roadside depressions, and power line rights-of-way (NCNHP 2001). Preferred soils range from moist to seasonally saturated sands and sands under a shallow organic soil layer to deep peat soils (USFWS 2011b, 2010).

Loss of habitat is primarily due to urban development, road building, and wetland drainage. Additionally, suppression of fire in natural areas leads to competition from dense stands of herbs, shrubs, and trees and increased shade (USFWS 2011b, 2010; NCNHP 2001).

2.5.2 Pondberry

Pondberry was listed as federally endangered in 1986 (USFWS 1993). It is an aromatic, deciduous woody shrub which grows up to 6 feet and reproduces vegetatively by above ground shoots, creating clonal thickets (NCNHP 2001; USFWS 1993). Leaves are alternate, drooping, oblong in shape, and sassafras scented. Flowers are small and pale yellow, appearing before the leaves (NCNHP 2001; USFWS 1993).

Flowers bloom from February to April and fruits are glossy, bright red, fleshy, and oval in shape (NCNHP 2001). Pondberry almost always occurs under natural conditions in wetlands (NRCS 2009) and is particularly associated with seasonally flooded wetlands (USDA 1993). Preferred habitat consists of open bottomland hardwood forests in inland areas, poorly drained swampy depressions, edges of swamps and ponds, and longleaf pine and pond pine forests (NCNHP

2001; USFWS 1993). Pondberry primarily occurs in somewhat shaded areas but is also found in full sunlight (NCNHP 2001). It grows in acidic and generally loamy soils and silty loams (USFWS 1993).

Loss of habitat is primarily due to land clearing for urban and agricultural development, wetland drainage, timber harvesting, and other forest management practices (NCNHP 2001; USFWS 1993).

2.5.3 Golden Sedge

Golden Sedge was listed as federally endangered in 2002. Golden sedge is a tall, slender, perennial sedge growing in tufted clumps to a height of 39 inches or more. Leaves are grass-like, narrow, yellowish-green in color, and up to 26 inches in length. The female floral and fruiting structures are conspicuously bright yellow and textured without curved projections. Fruits are produced mid-April to June (USFWS 2002b).

Golden sedge usually occurs in wetlands, requiring a high water table and open to partly open conditions maintained by fire (USFWS 2002b). It occurs mostly in ecotones between pine savannas and wet hardwood-conifer forests, such as partially shaded savanna swamp areas. It has also been found in disturbed areas including roadside and power line rights-of-way. Sandy soils overlying relatively alkaline marine-originated limestone deposits are preferred. Soils are very wet to periodically shallowly inundated (USFWS 2002b).

Loss of habitat is primarily due to urban development, road building, clay mining, and wetland drainage associated with agricultural and silvicultural practices. Additionally, suppression of fire in natural areas leads to competition from dense stands of herbs, shrubs, and trees (USFWS 2002b).

2.5.4 Cooley's Meadowrue

Cooley's meadowrue was listed as federally endangered in 1989. Cooley's meadowrue is a perennial herb which grows erect in full sunlight, but becomes lax and trailing in partial shade (USFWS 1994). Height is generally 39 inches, although it may grow over 6 feet in height in recently burned areas (NCNHP 2001). Leaves grow both basally and from the stem and are divided into three to more leaflets. A high degree of variability exists in leaflet shape and length (USFWS 1994; USFWS 2011b). Flowers are unisexual and without petals; however, male flowers present conspicuous lavender filaments. Sepals are present and range in color from green to pale yellow. Flowers bloom from June to July and fruits are tiny, narrow, and ribbed (USFWS 1994).

Cooley's meadowrue usually occurs in wetlands; however, it is occasionally found in drier, upland areas (NRCS 2009). The open to partially open habitat it requires can be achieved by fire

or mowing regimes. Preferred habitat consists of wet pine savannas, grass-sedge bogs, savanna-like areas, and woodland clearings in relatively alkaline soils. Cooley's meadowrue is also found in disturbed areas such as fire plow lines, roadside ditches, and power line rights-of-way (USFWS 1994; USFWS 2011b).

Loss of habitat is primarily due to urban development, road building, wetland drainage, and clearing practices associated with agriculture and silviculture (USFWS 1994). Additionally, suppression of fire in natural areas leads to competition from dense stands of shrubs and trees.

2.5.5 American Chaffseed

American chaffseed was listed as federally endangered in 1992 (USFWS 1995). American chaffseed is a perennial, erect, herb with unbranched stems (or stems branched only at the base), which grows to a height of 12 to 24 inches. The entire plant, including flowers, is densely hairy. Leaves are alternate, lance-shaped to elliptic in shape. Flowers are large, purplish-yellow, and tubular. Flowers bloom in the south from April to June and fruits are long, narrow capsules enclosed by sac-like structures (USFWS 1995).

American chaffseed usually occurs in wetlands; however, it is occasionally found in drier, upland areas (NRCS 2009). Open to partially open conditions are crucial to the reproductive and establishment success of American chaffseed and are achieved by fire, mowing regimes, or fluctuating water tables (USFWS 1995; USFWS 2010b). High fire frequency, especially during the growing season, appears to be required (Weakley 2008).

Preferred habitat consists of open pine flatwoods, fire-maintained savannas, sandhill-pocosin ecotones, and open grass-sedge systems in acidic, seasonally moist to dry, sandy or peaty soils (USFWS 1995). American chaffseed is partially dependent upon other plants as hosts (hemiparasitic); however, it is not host-specific, so rarity is not due to its preference for a specialized host (USFWS 2010b).

Loss of habitat is primarily due to urban development, road building, wetland drainage, pine forest management, planting of game food plots, and possibly commercial pine straw raking (USFWS 1995). Additionally, suppression of fire in natural areas leads to competition from dense stands of herbs, shrubs, and trees and increased shade (USFWS 1995; NCNHP 2001).

2.5.6 Red-cockaded Woodpecker

The RCW Recovery Plan (USFWS 2003) defines the primary core populations as those that will harbor at least 350 PBGs at the time of and after delisting. Populations of this size are above the minimum size considered necessary to withstand threats of extirpation from demographic stochasticity, environmental stochasticity, and inbreeding depression (2C). Populations of this size may not be capable of retaining sufficient genetic variability for long-term viability in the

absence of immigration (Lande 1995), but because retention of genetic variability is a direct function of population size, these primary core populations will retain more variation than secondary core and support populations. Conservation of within-population genetic diversity is a major function of primary core populations.

Although a minimum population size of primary core populations is necessarily identified in delisting criteria, primary core populations should expand to the maximum sizes the habitat designated for RCWs will allow, to retain as much genetic variation within the populations as possible. (Maximum size is generally based on 200 acres [81 hectares] per group). At downlisting, primary core populations may not necessarily contain 350 PBGs.

There are 12 designated primary core populations, located on federal lands including national forests, military installations, and one national wildlife refuge. Some state properties, such as Holly Shelter, support important segments of primary core populations.

2.5.6.1 Project Area Population Status

The CNCPC population consists of three separate properties: MCB Camp Lejeune, Croatan NF, and Holly Shelter. Because of the location and the distance between these three properties, the RCW Recovery Plan (USFWS 2003) is vague in categorizing this population as a demographically functional, single population of 350 PBGs at recovery. Of the 380 total active clusters needed for recovery of this primary core population, MCB Camp Lejeune is expected to sustain 173 active clusters, Croatan NF is expected to sustain 169 active clusters, and Holly Shelter is expected to sustain 38 active clusters.

2.5.6.2 Marine Corps Base Camp Lejeune Population Status

The Mission Compatible Recovery Goal for MCB Camp Lejeune has established a population goal of 173 active clusters as its contribution toward recovery, which was based on the calculation of the number of acres (approximately 36,992 acres) containing pine or pine-hardwood forest present in 1999 (USMC 1999, 2006). The Final INRMP for 2007-2011 contains the MCB Camp Lejeune 2006 RCW Management Plan, which provides the background and strategy of RCW management on the installation.

Not all active clusters contain a potential breeding group; some clusters contain unpaired males (single-male clusters) and some are used for roosting by groups whose primary residence is another cluster (captured clusters), so all counts of clusters do not necessarily result in similar population dynamics. In 2008, there were 88 active clusters on MCB Camp Lejeune, 78 of which (86.6 percent) contained PBGs (see Figure 1-1). There were 9 captured clusters, 1 single-male cluster, and 10 recruitment clusters that were not yet occupied (USFWS 2009). In 2010, the number of active clusters rose to 92 with PBGs recorded in 85 of the clusters (USFWS 2010a). An additional 16 inactive clusters were also recorded. In 2011, the number of active clusters rose

to 100, while PBGs rose to 88. There were six unoccupied clusters at the end of the 2011 breeding season (USFWS 2011a).

MCB Camp Lejeune's RCW population has been intensively monitored since 1985. Population demographics, reproductive success, and home range data is collected and interpreted annually. Breeding season monitoring data includes clutch sizes and fledgling success, with every fledgling receiving identifying bands. Breeding status of adult birds is also documented annually allowing accurate accounts of the number of helpers in the population. MCB Camp Lejeune's monitoring program will continue to remain consistent with 1999 Plan. This monitoring is essential to gauge population dynamics and growth.

MCB Camp Lejeune has made significant progress towards meeting the recovery goal. Since 1986, the population has nearly tripled. In the 1990s, RCW populations increased at one of the highest reported rates of all primary core populations (in the absence of translocation), demonstrating historically effective management techniques (USFWS 2003). The 2011 population of 100 active clusters represents 58 percent of the MCB Camp Lejeune population goal.

Modeling scenarios have indicated that the MCB Camp Lejeune RCW population may be divided into two subpopulations. The highest concentrations of RCW groups are in the training areas adjacent to and in the vicinity of G10 Impact Area. The birds in these areas are linked with each other, and with the clusters in the northeast corner of the installation, through dispersal (Walters et al. 2011). The eastern subpopulation is separated by Stone Bay and the New River from a smaller western subpopulation in the Verona Loop Training Area on the west side of the base. The Verona Loop population is centrally located within the geographic region with dispersal occurring between it and clusters located around the K-2 Impact Area and the Marine Corps Forces Special Operations Command (MARSOC).

2.5.6.3 Holly Shelter State Game Lands Population Status

The RCW Recovery Plan (USFWS 2003) has established a population goal of 38 active clusters for Holly Shelter Game Lands. In 2009, Holly Shelter Game Lands contained 51 total managed clusters which includes active, inactive, and recruitment clusters (Kenneth Shughart, personal communication, June 30, 2011). Thirty-four of the fifty-one clusters were active in 2009 (Bruggeman et al. 2010; see Figure 1-1). Most active clusters occur in the southern portion of the property, while the northern area is sparsely populated with a few active clusters. In 2010, the NCWRC reported that Holly Shelter Game Lands contained 36 active clusters with 29 PBGs; all detected PBGs attempted to nest (USFWS 2011c).

2.5.6.4 Croatan National Forest Population Status

The RCW Recovery Plan (USFWS 2003) sets a goal of 169 active clusters for the Croatan NF. In 2009, Croatan NF records indicate the presence of 55 active clusters on the property (USFWS

2011c). The majority of active clusters occur in the southern portion of the Forest and a second small subpopulation of active clusters occurs in the northeastern area of Croatan NF (see Figure 1-1). In 2010, the U.S. Forest Service reported 60 active clusters were monitored for breeding activity on the Croatan NF. Of these, 58 contained PBGs. Fifty-four groups attempted to nest (USFWS 2011c).

2.5.6.5 Other Project Area Red-cockaded Woodpecker Populations

The North Carolina Natural Heritage Program (NCNHP) has a few records of occupied RCW clusters in the Project Area that do not occur on state or federal lands. Notably, RCWs were found in forested lands in eastern Carteret County, east of the Adams Creek Canal and the South River as late as 2003 (NCNHP 2011). NCNHP data indicate that some of these groups used habitat in wet pine flatwoods as well as pond pine woodland (See Schafale and Weakley 1990 for a description of these natural communities). Based on examination of National Agricultural Imagery Program (NAIP) digital images (USDA FSA 2009), extant RCW groups could potentially exist in a variety of pine-dominated ecological communities in unlogged woodlands north of Open Ground Farms, south of Piney Island Bombing Range and west of U.S. Highway 70. Little information is known about the survivorship of these groups.

2.5.7 Federal Species of Concern

Several species in the proposed project area have been defined as species of concern by the USFWS (Appendix A; USFWS 2011b). Species of Concern are plant and/or animal species that are not yet federally listed as threatened or endangered under the ESA, but that are either designated as candidates for listing or are regarded as critically imperiled or imperiled throughout their range. While not currently protected under the ESA, conserving species at risk now may prevent the need to list them in the future.

Known populations of bald eagles (*Haliaeetus leucocephalus*) occur in Onslow and Pender counties, North Carolina (NCNHP 2008; USFWS 2011b; USMC 1999). Although the bald eagle has been removed from the federal list of threatened and endangered species, it is still protected under the Bald Eagle and Golden Eagle Protection Act. Under this law bald eagles are protected year-round from activities that may cause them to abandon a nest.

2.6 RED-COCKADED WOODPECKER BIOLOGICAL FUNCTION DETERMINATION OF COASTAL NORTH CAROLINA PRIMARY CORE POPULATION

A RCW population or subpopulation within the CNCPC population is defined as biologically functioning when population growth, persistence, and demographic and genetic connectivity are predicted to remain viable over time. The RCW Recovery Plan (USFWS 2003) has defined the number of active clusters which must be persistent on each property before each subpopulation is

deemed viable. The CNCPC population must support 350 PBGs (or 380 total active clusters) which are not dependent on artificial nest cavities to maintain population size in order to delist RCW. Additionally, the RCW Recovery Plan defines that at the time of delisting, 173 active clusters will be persistent on MCB Camp Lejeune, 169 will be on Croatan NF, and 38 will be present at Holly Shelter Game Lands. Each group should be managed to persist in an area of at least 200 acres. The population must be demographically and genetically functioning to be considered for delisting.

Currently, the CNCPC population as a whole occurs on three RCW recovery properties: MCB Camp Lejeune, Croatan NF, and Holly Shelter. During a census in 2011, 88 PBGs within 100 clusters were recorded at MCB Camp Lejeune with the most highly aggregated clusters on the eastern side of the property. In 2009, Croatan NF contained 58 PBGs within 60 clusters mostly aggregated in the south, and in 2010, 29 PBGs within 36 clusters occurred at Holly Shelter with most also aggregated in the southern portion of the property (see Figure 1-1). Other RCW clusters have been recorded in Carteret County, North Carolina, but further research is necessary to verify their presence (USFWS 2011c).

A functioning primary core, secondary core, or essential support population is defined by the RCW Recovery Plan (USFWS 2003) as one which is demographically and genetically functioning at recovery. Lowe and Allendorf (2010) recently reviewed and clarified the distinction between measures of demographic and genetic connectivity. Demographic connectivity is the degree population growth and vital rates in a focal population are affected by dispersal and net immigration. Another strong indicator of demographic connectivity between spatially distinct subpopulations is the degree vacant recruitment clusters become occupied by RCW immigrants with subsequent PBGs. Genetic connectivity can be measured in average heterozygosity rate within breeding groups (H_S), average genetic divergence among breeding groups (D_{ST}), and average rate of inbreeding (F) in a population.

Early models from Letcher et al. (1998) predicted PBGs of less than 100 would not remain viable over time if not highly aggregated, but groups as small as 49 PBGs could persist for 100 years if highly aggregated. Given the known locations of active clusters on the recovery properties, the highly aggregated clusters in eastern MCB Camp Lejeune and northern Croatan NF could potentially resist demographic stochasticity for 100 years. Highly aggregated clusters in southern Holly Shelter may persist for at least 20 years, given findings by Letcher et al. (1998) that groups of 10 to 20 highly aggregated clusters may resist demographic stochasticity for 20 years; however, these assertions are based on data produced by the early Letcher models (Letcher et al. 1998) that did not include a rigorous analysis of genetic connectivity.

To determine the true current functionality of the RCW CNCPC population, spatial modeling which included both demographic and genetic modeling was necessary. MCB Camp Lejeune and the USFWS accomplished this task by implementing a series of RCW IB-SEPMs. The following

sections describe the evolution of IB-SEPMs used to evaluate different populations of RCWs within their range and specific spatial modeling efforts made to determine the current biological function of the CNCPC population.

2.6.1 Red-cockaded Woodpecker Individual-based, Spatially-explicit Population Model History and Objectives

The advent of population viability analysis (PVA) developed quickly following Shaffer's (1981) application of a stochastic demographic and environmental population model of the grizzly bear (*Ursus arctos*) to estimate a minimally viable population. Gilpin and Soule (1986) introduced the term "population vulnerability analysis" to describe the analysis used to estimate a minimally viable population. Although their terminology was not commonly adopted, their conceptual model of the interactions among stochastic demographic, environmental, and genetic events affecting population size, viability, and extinction was generally accepted. Today, PVA is more commonly considered a quantitative assessment of the future status of populations based on factors affecting population growth, decline, persistence, and extirpation (Groom and Pascual 1997; Morris and Doak 2002) without any strict reference or objective of estimating a minimally viable population.

The availability of VORTEX, RAMAS, ALEX, and other computer software programs was a key factor in the proliferation of PVAs for a variety of species in the late 1980s and early 1990s (Beissinger 2002). These provided a demographic and, depending on the software, a genetic program to which users would input parameter data that was stochastically simulated to generate future populations over time with output on population size, growth or decline, and other data. Important differences existed among the model structure and processes simulated by these programs, affecting their potential suitability for particular species and data (Lindemayer et al. 1995). VORTEX is individual-based, although not spatially explicit, where the age or stage and life history fate of each individual is simulated and tracked. Stochasticity in VORTEX was simulated using Monte Carlo methods. Monte Carlo methods use random sampling from the probability of a demographic or genetic event as defined by the input parameter values. For example, the probability an individual survives at one-time step depends on the user-defined probability and the random value the program samples or draws from the probability distribution. In contrast, RAMAS simulates stochastic variation in demographic vital rates by the parameter value and its standard deviation in Leslie matrix, from which a random sample is drawn.

For either VORTEX or RAMAS, the user defines initial population conditions at time 0 and sets the number of future years for a simulation run, given the program structure and required parameters. Also, the user defines the number of simulations or replications. Given the average or frequency values of respective input parameters, the values from all simulations tend to converge or reflect these averages or frequencies; however, the future population size trajectory

over time for all simulations will vary around these central tendencies, reflecting the effects of stochastic variation.

In response to the availability of these programs and interest in RCW population viability several studies were performed to assess the value of PVAs in the management of RCWs. Haig et al. (1993) first used VORTEX (Lacy 1991) to evaluate the vulnerability of a small population at the Savannah River Site (SRS), South Carolina, and the relative contribution of RCW translocation to as a management intervention to support the population. They also used the genetics program in VORTEX to assess potential susceptibility to inbreeding depression. Stevens (1994) used VORTEX (Lacy 1991) and a Johnson-Emigh-Pollak (JEP) model (Johnson 1977; Emigh and Pollak 1979) with simplifying assumptions to heuristically assess RCW population sizes necessary to sustain a genetically effective population (Ne) of 500. Heppell et al. (1994) developed a deterministic stage-based Leslie population matrix, apart from available population software, based on males to evaluate effects of several different management alternatives to restore declining populations in the NCSH. Maguire et al. (1995) used RAMAS/stage to estimate the viability of a small RCW population at the Piedmont National Wildlife Refuge and Hitchiti Experimental Forest, Georgia, based only on female RCWs.

Investigators in each of these studies generally noted various limitations imposed by the applicable model, available data, and certain assumptions; however, all investigators recognized that RCW social structure and cooperative breeding behavior was not adequately represented. Indeed, prior to these investigations, Walters (1991) had identified how appropriate models must incorporate critical dynamics of RCW populations affected by the spatially fixed distribution of territories in association with the limited availability of cavity trees and clusters, the replacement of breeders in territorial groups by helpers in the same territory, and the dispersal behavior of RCWs from other territories competing for the breeding vacancy at available clusters; thus, RCW population dynamics and any reduction in population size is governed more by the number and location of suitable territories for PBGs with helpers than a reduction in individual survival and reproduction which tends to affect group size (Walters 1991). Accordingly, Stevens (1994) asserted that the group-based social system in combination with restricted dispersal and cavity-limited territories were actually or potentially significant features of a viability model. Also, Heppell et al. (1994) concluded that an IB-SEPM was needed because spatial elements were important in RCW population dynamics.

2.6.2 1998 Letcher Model

The application of IB-SEPMs for RCW conservation has demonstrated how density and spatial distribution of breeding groups affect gene flow, genetic drift, inbreeding, and population persistence in response to demographic and environmental stochasticity and habitat fragmentation (Letcher et al. 1998, Daniels et al. 2000, Walters et al. 2002b, Bruggeman and Jones 2008, Bruggeman et al. 2010). The first RCW IB-SEPM was reported by Letcher et al.

(1998) to account for cooperative breeding behavior and spatial effects of limited RCW dispersal among established territories to replace breeding vacancies. For example, helpers that transition to breeders in their natal territories reduce impacts of breeder mortality on population dynamics that are difficult to represent by other modeling methods. The model was based on a computer program and code developed by the investigators. The objective was not to simulate RCW population dynamics as a future prediction of population trend for an actual RCW population. Instead, the model was developed to predict population stability, with demographic stochasticity.

The RCW IB-SEPM by Letcher et al. (1998), commonly known as the Letcher model by the USFWS, significantly improved understanding of the role of spatial territory and group dynamics on RCW population growth and persistence. The Letcher model is spatially explicit for the landscape and location of each RCW group territory and individual RCW during each 3-month time step of the simulation period. The landscape consists of fixed RCW territories around centers of cavity clusters and the non-territory habitat across which RCWs disperse. The geographic information system (GIS) layer used to represent habitat in the landscape only includes habitat suitable for RCW dispersal. RCWs in actual populations may encounter habitat unsuitable for dispersal; however, this is a simplifying model feature representing ideal conditions to more clearly ascertain the relationship between territory density and population dynamics without the contributing effects of a habitat mosaic. The landscape is static and does not change except when a territory is abandoned for a 5-year period, after which it is no longer available for RCWs. This reflects observed conditions in the NCSH where cavities deteriorate and suitability becomes limited after a 5-year unoccupied period (Copyeon et al. 1991), at least without management.

The location of each territory is a fixed area around the center of each cavity cluster, varying from a maximum radius of 0.5 kilometers to a minimum of 0.3 kilometers where the area of more closely spaced territories were partitioned. This function of territory size regulates the distance between RCW groups, which also affects dispersal distances for RCWs competing for breeding vacancy. These density and distance functions appropriately reflect those from study populations in the NCSH. The actual home range and foraging area for each group is not a function of the model. Whether a territory or home range is circular does not affect the simulated populations because the most important dynamic is the location of each group's cavity cluster. New territories and clusters are not created, which only occurs at a very low rate in actual populations due to colonization of unoccupied habitat or subdividing an existing territory (Hooper 1983, Walters 1991).

2.6.3 Demographic Assumptions of Letcher Model

Demographic stochasticity is simulated by the probabilities of individuals surviving each 3-month period and transitioning to the next age or stage. Stochasticity also is incorporated by probabilistic components of reproductive success. The model is male- and female-based, derived

from extensive demographic and other data during a 15-year monitoring period of over 200 completely color-banded groups in the NCSH. The location, age, and status of each individual (e.g., floater, breeder, helper) was annually monitored during these studies, as well as reproductive success and the identification of each fledgling in its natal cluster and group. These data provide the annual transition probability from one model status class to another. For males, status classes are birth, fledgling, helper, dispersing fledgling, floater, solitary, breeder, and death. Female status classes are birth, dispersing fledgling, floater, breeder, and death. Stochasticity is generated from these transitional probabilities by Monte Carlo methods in the program that produce a random number from 0 to 1, which is compared to the parameter probability (e.g., if the random number is equal to or greater than the transition probability, then a status transition occurs). For example, if the probability is 0.81 a male fledgling will remain on its natal territory, which will become a helper if it survives (0.5 annual mortality) to age 1.

Reproductive success, based on monitoring data, was modeled as a stochastic consequence of the probability of attempting to breed, probability of nesting success (e.g., produced fledglings), number of fledglings produced in successful nests, and the probability of re-nesting after initial nest failure.

2.6.4 Letcher Model Parameters for Movement and Dispersal

All juvenile females disperse from their natal group and territory. Females only rarely have been observed to remain in their natal territory as a helper, which is not modeled as an insignificant factor in population dynamics. Juvenile females that survive (0.58 annual probability mortality) to 1 year of age either become floaters or breeders. Male fledglings that survive and disperse from their natal territory become floaters, breeders, or helpers in another territory. The IB-SEPM method differs from age- or stage-based models that are not spatially explicit because the transition of a dispersing juvenile male or female to a breeder, for example, is the spatial outcome of the likelihood of encountering a territory and successfully competing for the breeding vacancy. This is a consequence of the model parameters for direction of movement, speed and distance of dispersal, the search or perceptual range, the distance and density of other territories, presence of territories with breeding vacancies, and competition.

Dispersal behavior for the IB-SEPM was modeled from monitoring data of over 1000 dispersal events of male and female juveniles, helper males, and breeding females. Dispersal direction was random and continued in a straight line during each 3-month time step because field observations of floater movement rarely were erratic. Given that all habitats in the landscape were modeled as suitable for dispersal, there was no potential effect of habitat type on dispersal direction. Dispersal speed was constant for each RCW class, as estimated from empirical monitoring data on annual dispersal distances (male fledgling 5.1 kilometers/year, adult male 2.3 kilometers/year, female fledgling 4.8 kilometers/year, adult female 4.8 kilometers/year). Any male helper, floater, or solitary-male on another territory competed for any breeding vacancy within 3 kilometers of

their location at each time step. Competition rules determined the outcome as follows. The oldest helper always won. In the absence of helpers, the closest of any other male within 3 kilometers wins at the time step of vacancy, of which the oldest bird succeeds when two or more occur at the same distance. For females, the closest of all floaters and widowed breeders within 3 kilometers of a breeding vacancy won the vacancy. Breeder females disperse following the death of their male breeder if the replacing male is their father or son, reflecting incest avoidance (Walters et al. 1988). Individuals that died were removed from the simulation, as were individuals that reached the boundary of the landscape and were treated as emigrants. There was no immigration.

2.6.4.1 Initial Conditions and Model Simulations using Letcher Model

Initial population conditions for all simulations reflected NCSH study population conditions. Territories with breeding pairs were randomly assigned where each had a 0.90 probability. Helpers were randomly assigned by rules reflecting observed group size and composition in the study population, so about 50 percent of the PBGs had no helpers and the remaining had 1 or more helpers. Territories without a breeding pair were occupied by a solitary male.

Seven hypothetical populations were simulated in an arbitrarily fixed 32x24-kilometer landscape to evaluate: (1) model behavior and the sensitivities of population mean growth rate (λ) to changes in model parameters; (2) effects of good years and bad years on initial population conditions; and (3) effects of the spatial distribution and number of territories. Each of the seven populations were initiated with the same number of territories (e.g., 25, 49, 100, 169, 250, 500, and 750), but in four different states of territory densities or aggregation: minimum density, maximum density, and 25 percent and 75 percent of maximum density. Territories with a maximum aggregation were in a single dense patch, with each territory touching another. At the minimum density, territories were randomly assigned locations in a 32x24-kilometer landscape. Each simulated population was run for 100 years and replicated 20 times.

Of the results, the USFWS was particularly interested in the strong effect of territory number and density on population dynamics and persistence. Populations of less than 100 territories declined unless maximally aggregated; however, almost all territories remained occupied in populations with 49 maximally aggregated territories. Populations as small as 25 territories were surprisingly persistent, although with a long-term declining trend and λ of 0.99 where about 65 percent of the initial territories remaining occupied on average. Populations of 49 initial maximally aggregated territories were more stable than those with 169 and 250 minimally aggregated territories. Effects of demographic stochasticity were most evident in the smallest population of 25 territories by the greater variation in growth rate and proportion of territories remaining occupied. All territories remained occupied in the largest populations of 500 and 750 territories regardless of initial territory density in the landscape.

Demographic and dispersal parameters with the greatest effect to growth rate in the larger more aggregated population were different than those in the smallest population with the least aggregated territories. The three parameters for which population growth rate was most proportionately sensitive in the simulated population of 169 were increasing fledgling production, increasing female breeder mortality, and increasing female disperser mortality. In the population of 25 territories, the three parameters contributing the greatest proportional sensitivities were female dispersal mortality, number of fledglings, and female dispersal search range. Also, the proportional sensitivity of lambda for most all parameters was greater in the smallest population than in the larger population.

2.6.5 Applications of the Letcher Model

The Letcher model enabled analyses of critical spatial dynamics that earlier models could not provide. The USFWS and others used the model for other spatially explicit assessments to support decisions in several applications. These included management of critically small RCW populations (Crowder and Priddy 1998), spatial population structure and persistence (Walters et al. 2000b, 2000c), and recruitment clusters for population growth (Walters et al. 2001).

For example, these model simulations revealed how very small theoretical populations of only 10 to 20 highly aggregated territories were remarkably persistent over a 20-year period. Although slowly declining, such critically small populations with intensive interventional management could be sustained (Crowder and Priddy 1998). In the NCSH, factors contributing to population viability and structure were assessed by applying the model to actual population subunits at Sandhills West (Sandhills Game Lands, Camp Mackall), Sandhills East (Fort Bragg, Southern Pines), and the Northeast Area of Fort Bragg. Beginning with the number and location of occupied territories in 1997, these population units were simulated for a 100-year future period. Among the results were the Sandhills East and Sandhills West units should be considered demographically separate populations, and recruitment clusters at particular locations through the Greenbelt and Overhills tracts would stabilize and link the Northeast Area to the Sandhills East population segments (Walters et al. 2000c). Similar issues concerning population structure and persistence among RCWs at Eglin Air Force Base, Blackwater State Forest, and Conecuh NF were addressed by model simulations of these populations and interrelationships (Walters et al. 2000b). For example, results supported other empirical data that the Eglin Air Force Base was subdivided as an East and West population where the East was more vulnerable due to a smaller number of more highly dispersed clusters. This also supported management recommendations to increase recruitment clusters in the East to demographically connect the West population unit. And at the SRS, the population as it existed in 1995 with 20 PBGs was modeled for a future 20-year period to provide support of other analyses on factors contributing to its recent decline (Walters et al. 2001). The decline in number of occupied RCW territories by model simulations in this small population reflected spatial effects of their distribution and density, as well as the

need to establish recruitment clusters at more spatially strategic positions relative to active clusters.

These studies and applications continued to elucidate how the spatial distribution of territories are critical factors affecting persistence of populations smaller than about 250 groups; moreover, management priorities to enhance population stability and viability cannot be simply determined according to the number of breeding groups. Simulating actual populations with IB-SEPMs is an important tool to understand how population dynamics, size, and structure are affected by the spatial distribution and density of breeding groups.

2.6.6 The Walters Individual-based, Spatially-explicit Population Model

Demographic, environmental, and genetic stochasticity and natural catastrophes are the four primary factors affecting species and population persistence (Shaffer 1987). Walters et al. (2002b) further developed the RCW IB-SEPM by Letcher et al. (1998), which included demographic stochasticity, by incorporating environmental stochasticity. The 19 model parameters were the same as in the Letcher model, to which environmental stochasticity was simulated from 14 years of empirical data for annual variation in survival and reproduction in NCSH populations. The value of a parameter for a particular year, for example male breeder survival, was determined as a random variate selected from the probability distribution among years; thus, environmental stochasticity was added to the same eight mortality and 10 fecundity parameters. The 14 parameters for RCW movement and dispersal remained unchanged.

Walters et al. (2002b) evaluated effects of demographic and environmental stochasticity to RCW population viability as spatially affected by spatial density and aggregation of territories. Five theoretical populations of 25, 49, 100, 250, and 500 initial territories were simulated as before on a 32x24-kilometer landscape, but with only two levels of territory aggregation for each population. The minimum aggregation consisted of territories randomly distribution on the landscape. The second level was a moderately high aggregation, representing 25 percent of a maximum aggregation. In addition, the smaller populations of 25, 49, and 100 territories were simulated on a second landscape that was reduced from the area of the 32x24-kilometer landscape to generate territory densities comparable for the larger populations of 250 (3.3 territories/square kilometer) and 500 (6.5 territories/square kilometer) territories at minimum and 25 percent aggregations. Territories were randomly distributed in these adjusted landscapes, which were denser in comparison to the minimum and 25 percent maximum aggregations on the 32x24-kilometer landscape.

Once again, populations of 250 and 500 initial territories at these landscapes and levels of aggregation were viable with an equal or greater number of territories on average at the end of the 100-year simulation. The population of 100 territories was only stable and viable, with a λ of 1, at the greatest territory densities (6.5 territories/square kilometer). On average, slightly more

than 100 territories persisted in initial populations of 100 at densities of 3.3 territories/square kilometer, although performance was variable with some populations declining to about 50 percent of the initial territories remaining as occupied by RCWs. Populations of 49 territories increased only at the greatest territory densities, but declined at all other lower levels of aggregation. The smallest population of 25 territories declined to extirpation on average at the minimum aggregation. At the highest territory density (6.5 territories/square kilometer), populations of 25 initial territories were extirpated about 66 percent of the time during the 100-year period, and when persistent with only about seven surviving territories on average.

Walters et al. (2002b) concluded that population performance with environmental stochasticity was very similar to that in the previous study (Letcher et al. 1998); moreover, effects of environmental stochasticity to these RCW populations were generally small relative to the population viability analyses of other species. Spatial distribution and territory density continued to exert a strong effect, but the cooperative breeding behavior with a large non-breeding class also reduced adverse effects of both demographic and environmental stochasticity to breeder mortality. Male helpers that transition to breeders on their natal or nearby territories within their search and dispersal range help compensate for male breeder mortality; however, the likelihood of this transition is reduced when territory aggregation and density is poor and adjacent territories are beyond the normal dispersal and search range of helpers. This study was not designed to model an actual population, but the size and aggregations of the populations of 49, 100, and 250 initial territories were representative of actual study populations in the NCSH, MCB Camp Lejeune, Croatan NF, and Eglin Air Force Base.

2.6.6.1 First Validation of Walters Individual-based, Spatially-explicit Population Model

Schiegg et al. (2005) formerly validated the accuracy of the Walters model (Walters et al. 2002b) by comparing results of simulations for two actual populations (MCB Camp Lejeune and NCSH) with observed patterns and parameter values for those populations. Primary model performance was assessed according to predicted number of breeding pairs, number of territories gained and lost, and number of individuals in each status class. Secondary performance criteria were the generated parameter values for natal dispersal distances, percentage of male and female fledglings attaining breeding status, the age distribution for first breeding, and the age distribution of breeders at the end of the simulation period. Investigators used a qualitative procedure to visually compare the computed mean and standard deviations of model-generated parameter values to those actually observed in the populations.

The landscape at MCB Camp Lejeune and the NCSH was derived from actual landscape and habitat classification data for these populations. The center for each RCW territory was either the coordinates of the actual nest cavity tree, the center for all cavity trees, or the arithmetic mean of Universal Transverse Mercator (UTM) coordinates of all foraging locations obtained for a group during breeding season monitoring. The landscape and initial territories represented those in

1988 at MCB Camp Lejeune and 1987 in NCSH. Demographic and dispersal parameters were the same as in earlier IB-SEPMs (Letcher et al. 1998, Walters et al. 2002b), except the numerical values for 7 of 10 fecundity parameters differed, apparently in response to the reduced time period for these data. Annual RCW immigration was modeled for MCB Camp Lejeune, at the annual observed rate of 1.6 females/year. Initial population conditions for the percentage of occupied territories (active clusters) with breeding pairs and solitary males, and the number of male helpers were the same as in earlier models. Each population was simulated or run 100 times for a period of 12 years. Overall, investigators concluded that complex RCW population dynamics were modeled "with high precision", although predictions were less accurate for MCB Camp Lejeune.

The NCSH simulated population increased to an average of 230.3 ± 31.4 breeding pairs in 1999, compared to the actual 221 pairs, which overestimated population size by 4 percent. The actual population gained 9 territories, while the simulated population increased an average of 9.5 ± 3.5 territories. Actual growth and number of breeding pairs usually were within the range of variation for predicted population size and growth. Percentage of RCWs as female breeders, male breeders, hatchlings, helpers, floaters, and solitary males at the end of simulated populations was very similar to the actual population. Median natal male dispersal distances also were in very close agreement between simulated (0.9, 0.0 – 2.0 interquartile) and observed (0.9, 0.0 – 3.1) values. Female natal dispersal distances were less in simulation populations (2.2, 1.4 – 3.2 vs. 3.9, 1.7 – 6.2). Simulated and actual population percentages were comparable for the percentage of male fledglings that gained breeding status by either dispersing at year 1 (6.2 ± 0.02 percent versus 5.5 percent) or by transitioning from helper status on their natal territory (3.9 ± 0.01 percent versus 1.1 percent). The percentage of female fledglings that dispersed and secured a breeding position at age 1 were greater in the simulated population (32.3 ± 3.5 percent versus 25.8 percent). The age of male and females at the time of first breeding was comparable, although the percentage of females simulated as 1-year-old breeders (94 percent) was slightly greater than observed (89 percent). And the age distribution of breeding males and females in the simulated population in 1999 compared closely to the actual population.

The actual MCB Camp Lejeune population was 50 breeding pairs in 1999, compared to the simulated average 22 ± 6.3 pairs. The simulated MCB Camp Lejeune population declined during the 1988 – 1999 period, while the actual population increased. The simulated average number of breeding pairs was 44 percent less than observed. Percentage of RCWs as female breeders, male breeders, hatchlings, helpers, floaters, and solitary males at the end of simulated populations was very similar to the actual population. Median natal male (0.8, 0.0 – 1.9 interquartile) and female (2.0, 1.2 – 2.9) simulated dispersal distances were less than observed (male 1.6, 0.0 – 4.9, female 4.2, 2.2 – 7.7). Simulated and actual population percentages were comparable for the percentage of male fledglings that gained breeding status by either dispersing at year 1 (5.5 ± 1.9 percent versus 4.6 percent) or by transitioning from helper status on their natal territory (3.7 ± 1.7

percent versus 2.8 percent). The percentage of female fledglings that dispersed and secured a breeding position at age 1 were greater in the simulated population (31.1 ± 3.9 percent versus 19.9 percent). The age of male and females at the time of first breeding was comparable, although the percentage of females simulated as 1 year-old breeders (94 percent) was greater than observed (63 percent). And the age distribution of breeding males in the simulated population in 1999 was comparable to the actual population, although the predicted proportion of breeding females at ages 2, 4, and 5 were greater than observed and less at ages 1 and 3.

The greatest differences between simulated and reference populations was the population size (breeding pairs) at MCB Camp Lejeune. Investigators believed the underestimated growth and number of breeding pairs was most likely an outcome of intensive recovery management at MCB Camp Lejeune with contributing factors. The MCB Camp Lejeune population actually increased by five groups in response to recruitment clusters during this period. Growth in this model was limited to budding at an average annual probability of 0.01 for an occupied territory to become divided as two territories.

The model and simulated populations did not include growth in response to recruitment clusters. Modeling with the addition of recruitment clusters would increase growth rates when their location was within search and dispersal distances, but this alone should not account for the difference between the predicted average number of 22 pairs and the actual 50 breeding pairs by 1999. A secondary effect of a small number of recruitment clusters, however, may positively affect spatial distribution and density of occupied clusters to support population growth.

Also, the model did not incorporate growth by pioneering, which is the establishment of new clusters and territories by creating new cavity clusters in unoccupied habitat. Pioneering is rare in most populations (Conner et al. 2001) because RCWs normally gain breeding positions and greater reproductive success by competing for existing breeding vacancies (Walters 1991) rather than excavating new cavity clusters. Pioneering is further limited in most populations by habitat without sufficient old and large pine for natural cavities. At MCB Camp Lejeune, however, actual pioneering is much greater than most populations, accounting for a population growth rate of about 1.5 percent per year. In addition, RCWs in coastal populations as MCB Camp Lejeune typically have higher survival and lower fecundity than interior birds as in NCSH. Modeling the MCB Camp Lejeune population based on NCSH demographic parameters may have been a contributing factor.

2.6.6.2 The Red-cockaded Woodpecker Decision Support System

In 2006, the DoD Strategic Environmental Research and Develop Program (SERDP) approved and funded a project to develop, demonstrate, and validate the Walters model (Walters et al. 2002b) as a user-based windows (MS Windows) GIS application of the RCW IB-SEPM. The interest, demand, and earlier applications of the model revealed a need to provide a user-based platform for model analysis; furthermore, the spatially explicit model was needed to more

effectively support decisions on identifying and managing critical habitat land parcels on and off DoD installations in a variety of applications concerning the landscape for RCW recovery and military training. The model product of this project is commonly known as the RCW DSS for which the final SERDP report was produced in January 2011 (Walters et al. 2011).

Further developing the IB-SEPM involved modifications and enhancements to the program code and structure as well as incorporating more recent and updated biological data. The DSS was programmed as an ArcGIS interface with interactive toolbars, including user documentation on system requirements, program setup, simulation scenario management, data input and format requirements, output data and GIS files, and simulation options. Alterations to the original program code were minimized to avoid and reduce errors by operating a Dynamic Linked Library in Windows to ESRI ArcMap. These alterations represented high-level programming to establish a user interface. To verify that these transformations did not fundamentally or erroneously alter the original population model, the performance of the old model for a number of scenarios at the MCB Camp Lejeune was compared to those generated by the RCW DSS, as described below.

Low-level modifications to the original code were required to incorporate new data from research and other more realistic biological or ecological conditions. These changes involved RCW dispersal, habitat types in the landscape, recruitment clusters, and demographic data for coastal and inland populations.

A reevaluation of juvenile (less than 1 year old) dispersal behavior included recent radio-telemetry studies in the NCSH at Fort Bragg (Kessler et al. 2010). The old model simulated juvenile female dispersal as a straight-line event in a random direction from the natal cluster, with movement at a fixed speed (4.8 kilometers/year) and competition for any breeding vacancy within 3 kilometers of their current position. Telemetry studies revealed a bimodal dispersal distance of juvenile females in response to two distinctive behaviors. First, juvenile females actually engaged in extra-territorial forays while resident at their natal cluster, interacting with other resident groups; thus, juvenile females acquired knowledge of other territories and groups prior to a foray or dispersal to one of these groups. The second behavior was a “jump” dispersal to other clusters at distances much greater than extraterritorial forays. The DSS model incorporated these findings by enabling juvenile females to compete for breeding vacancies during extraterritorial forays 6 kilometers from their natal cluster. After 1 year of age without obtaining a breeding vacancy, they disperse from their natal cluster according to the parameters of the previous model.

Juvenile dispersal behavior also was reevaluated by an analysis of historical data from a color-banded population in the NCSH during 1996 – 2005 (Kessler and Walters, unpublished data). By comparing the straight-line paths from each territory to other known territories with breeding vacancies, there were no differences in the forest type (pine versus hardwood) or habitat quality

(high versus low quality pine) for territories where breeding vacancies were acquired upon dispersal and those not acquired; however, forest gaps affected female dispersal. These data were incorporated in DSS parameters by restricting juvenile females from foraying across forest gaps of 150 meters or greater. After age 1 and without a breeding vacancy, they disperse and compete for breeding vacancies within 3 kilometers of their current position by the parameters of the previous model, but the probably of crossing a gap between 150 and 630 meters decreases with gap length as:

$$p = (-0.00163 * \textit{gap length}) + 1$$

This feature also incorporates the jump distance behavior. Once a gap is encountered by a floater female (greater than 1 year of age) that is not crossed, an alternative radial direction is evaluated for gaps along the next 100-meter step. The closest radial direction to move the next step to the original direction is selected, regardless of any other gaps beyond the 100-meter step distance. Dispersing males from their natal territory after the first year (male floaters), cross all gaps, and depart in a random direction in a straight line as in the old model because they are not gap sensitive. DSS gaps are represented and coded by the user as open, water, or other.

2.6.6.3 Decision Support System Validation

The DSS was conservative in predicting primary model attributes of population size (number of occupied territories) for NCSH and MCB Camp Lejeune. The actual NCSH population (occupied territories) increased during this period, while the DSS model predicted a very slight net decline. Actual number of territories was not reported, but the graphs indicate the natural population increased from about 225 to 250 territories. Number of territories initially increased slightly in the simulated population, and then remained relatively stable with only a very small net decline below about 225 territories. With recruitment clusters, actual population increased to about 280 clusters, although the simulated population performance was very similar to that without recruitment clusters. There was large variation in the number of occupied territories, where the standard deviation of the mean number at year 2007 appeared to be about 50 territories. The predicted population as simulated in the first validation (Schiegg et al. 2005) was about 4 percent greater than the observed population. In the DSS, the predicted number of occupied territories at year 2007 was about 10 percent less without recruitment clusters and 20 percent less with recruitment clusters.

The MCB Camp Lejeune population increased substantially more than the simulated population, with or without recruitment clusters. From an initial population of about 47 territories, the actual population increased to about 60 territories without counting recruitment clusters and 70 territories with recruitment clusters. The simulated population was essentially stable, with about 46 occupied territories without recruitment clusters and 49 occupied territories on average with recruitment clusters at year 2007. Variation in the simulated number of occupied territories was

much less in magnitude relative to the mean number compared to the NCSH. The validation exercise for the previous MCB Camp Lejeune model predicted a much smaller and slightly declining population relative to the actual population. Number of occupied territories in the DSS simulated population were about 23 percent less without recruitment clusters and 30 percent less than with recruitment clusters. In the validation for the previous model, the simulated population number of breeding pairs was 40 percent less than actual at the end of the simulation period.

The percentage of birds by social and status class structure (breeders, helpers, floaters, solitary males) was comparable for actual and simulated populations. Floaters were underestimated in all simulations, helpers were underestimated in the NCSH, and helpers were overestimated at MCB Camp Lejeune. The larger class of helpers in the simulated MCB Camp Lejeune populations contributed to the much greater differences in average group sizes for the actual versus simulated population. Mean group size in simulated MCB Camp Lejeune populations at year 2007 was about 3.6 with and without recruitment clusters. Actual mean group size was about 2.8 with and without recruitment clusters. Group sizes were not reported in the earlier validation by Schiegg et al. (2005).

Mean natal dispersal distances (kilometers) of males to breeding positions in other territories in the NCSH were overestimated in simulations with and without recruitment clusters, and underestimated at MCB Camp Lejeune. For females, the same parameter was underestimated by 1 to 1.35 kilometers, depending on the population, with and without recruitment clusters in both populations.

2.6.7 Landscape Equivalency Analysis and Pattern-oriented Modeling

In an effort to reduce uncertainties in DSS model parameters, especially their effect on simulating RCW dispersal across a heterogeneous landscape of suitable and unsuitable habitat, the Walters IB-SEPM was further developed to incorporate LEA. LEA evaluates how rates of RCW recruitment and migration change across the spatially explicit landscape with changes in habitat. LEA quantitatively computes RCW ecological services in terms of abundance (number of breeding groups) and genetic attributes. The LEA method differs from the RCW DSS by combining IB-SEPMs, POM, and genetic models as an accounting system to assess how different habitat parcels affect RCW ecological services in terms of abundance and genetic variance over time. POM uses observed spatially explicit landscape and individual RCW patterns to reduce uncertainties in the model parameters by comparing the ability of many different IB-SEPMs to produce observed patterns (Bruggeman et al. 2007). The RCW DSS, for example, is based on two model parameterizations, one for inland and the other for coastal populations. In LEA/POM applications, an initial set of thousands of models are reduced to a smaller set of multiple parameterizations selected according to pattern fulfillment criteria from observed parameter patterns in actual populations; thus, validation is an inherent POM process to generate model parameter values and combinations.

2.6.8 Pattern-oriented Modeling

Good instruments of policy, such as habitat trading, need to be able to consider the influence of key uncertainties regarding the system being managed. The most robust decisions under any policy are those able to achieve management objectives under a variety of possible states of nature (Hilborn and Ludwig 1993). Therefore, uncertainty regarding critical biological processes required to maintain persistent subdivided populations should be the focus of any scientifically defensible habitat trading program (Bruggeman et al. 2007).

IB-SEPMs were initially criticized for containing large uncertainties due to the amount of data required to parameterize models of complex systems (Wennergren et al. 1995; Ruckelshaus et al. 1997; Beissinger and Westphal 1998); however, POM has been derived to construct and validate these models with less data than previously imagined (Grimm et al. 2005; Wiegand et al. 2004a). POM accomplishes this by using additional information encoded in observed population-level patterns to reduce parameter error, providing a method for indirect parameter estimation. Parameter error is the uncertainty associated with the parameter values used in a submodel. POM reduces parameter error in IB-SEPMs by removing parameterizations not capable of reproducing biological patterns observed in nature (Grimm et al. 2005). A pattern is defined as anything beyond random variation, or any signal beyond noise (Grimm et al. 1996).

To apply POM, one must first determine the range of possible parameter values based on expert knowledge or parameters derived in landscapes where data are more abundant. Second, the range of possible parameter values is subdivided into equidistant values. Third, stratified sampling of possible parameter sets with replacement is used to combine all possible parameter values that are treated as uncertain. Fourth, the IB-SEPM is run with different parameterizations to sample a large number of possible parameter combinations. In the last step, parameterizations unable to reproduce RCW patterns observed on Camp Lejeune are removed from consideration through statistical comparisons between data produced by the simulation (i.e., expected patterns) and observations of RCWs on Camp Lejeune (i.e., observed patterns), in a process referred to as “filtering”. Below, we describe how POM was applied under our SERDP contract to evaluate uncertainty in the Gap/Jump dispersal model derived from analysis of bird banding data at Ft. Bragg (SI-1472; Kelser and Walters in prep). The following analysis is an example of how POM can be used to fit models derived in one landscape (i.e., Ft. Bragg) to apply them in a new landscape (i.e., MCB Camp Lejeune).

2.6.9 Reliability of Models

A model is a simplified representation of a real world system. Model credibility is a “sufficient degree of belief in the validity of a model to justify its use for research and decision making” (Holling 1978; Sargent 1984; e.g., Rykiel 1996). The credibility of any computer model is the degree users find the output as an acceptable representation of the intended real world system, as

assessed by a process of model validation and verification (Shannon 1975). Validation has been defined as the "substantiation that a computerized model within its domain of applicability possesses a satisfactory range of accuracy consistent with the intended application (Schlesinger 1979; e.g., Sargent 1996). A validated model is "acceptable for its intended use because it meets specified performance requirements" (Rykeil 1996). Verification substantiates the model form or structure as sufficiently accurate to achieve objectives. For computer models, verification frequently means the computer program is coded and structured properly to represent the real world (Sargent 2007).

Rykiel (1996) reviewed the history and scientific debate on validation terminologies and tests for ecological models, finding no simple or universally accepted definition of validation for models developed by scientists or used by others. This is a consequence of the diverse structure and purpose of ecological models as well as semantics. He (1996) concluded that validation is a test of acceptability depending on the purpose of the model, the criteria for acceptability, and the context for model operation. For IB-SEPMs, Bart (1995) also reviewed various precautions and recommendations for model "evaluation", adopting the definition of Marcot et al. (1983) as "the determination of the usefulness and accuracy of model predictions." Bart (1995) recommended four major categories of analysis for effective model evaluation: the objectives, a model description, analyses of model reliability, and synthesis.

2.6.9.1 Limitations in Individual-based, Spatially-explicit Population Models

Key decisions by the USFWS and MCB Camp Lejeune can be supported by population models which help determine if a candidate RASP property, when restored with suitable RCW habitat, will contribute to the recovery of the CNCPC population by supporting persistent RCW groups that demographically and genetically function with identified CNCPC subpopulations. The DSS and LEA models simulate the population dynamics and complex cooperative breeding behavior of RCWs by simulating the life of each individual RCW from birth to death, including its location and movement in the landscape over a time series. Both the DSS and LEA have been validated and verified as sufficiently credible to support these analyses and decisions, although within limitations.

Numerous improvements have been made to original PVAs, as evidenced in the history of RCW population models previously outlined; however, the most advanced models still have limited capabilities. The 1998 Letcher model greatly improved upon PVAs by capturing the cooperative breeding structure and associated group dynamics in the RCW social structure. It predicted the annual transition probability from one model status class to another and movement and dispersal behavior of male and female juveniles, helper males, and breeding females. The Letcher model also adjusted population growth rates in simulations to model differences between sparsely and highly aggregated clusters on the landscape; however, the landscape used in this model was

static, except when a territory was made unavailable for recruitment from the model after abandonment for a 5-year period.

Walters et al. (2002b) improved the Letcher model by incorporating survival and reproduction parameters based on monitoring data to simulate environmental stochasticity. Investigators tested the effect of demographic and environmental variation on RCW viability as affected by differing cluster spatial arrangements and levels of aggregation at the NCSH site. Schiegg et al. (2005) completed a first validation of the Walters et al. (2002b) model by comparing NCSH and MCB Camp Lejeune population data with empirical data for each property. Comparisons of model results and data at NCSH were fairly similar, but demonstrated an underestimation of breeding group size at MCB Camp Lejeune. Intensive habitat management by MCB Camp Lejeune that was not represented in simulations, a low annual budding rate set in model parameters, and the inability of the model to simulate pioneering may have contributed to the differences.

Walters et al. (2011) further improved the model by incorporating new RCW data, restricting juvenile females from foraying across forest gaps of 150 meters or greater, and automating the process with the production of the DSS. A validation of the DSS resulted in closer estimations to actual population data at MCB Camp Lejeune than in previous analyses, but the model still underestimated breeding population size.

Bruggeman et al. (2007, 2008) further enhanced RCW IB-SEPMs, based on the Letcher model (Letcher et al. 1998) and Walters model (Walters et al. 2002b), by incorporating POM to reduce uncertainty in estimating model parameters and developing LEA to quantify how changes in landscape structure affects patterns of RCW abundance and genetics (e.g. SERDP 2012). This iteration can model population sizes based on gradual cluster availability over time as habitat matures. Cluster habitat remains available for recruitment throughout the simulations, regardless of whether it has been previously abandoned by RCWs. POM was used to develop fulfillment criteria from thousands of observed parameter patterns in models based on actual populations.

Although much progress has occurred with each new model and the DSS has been validated and verified, the two most recent models, the DSS and the LEA/POM, still potentially underestimate population breeding sizes at MCB Camp Lejeune. Predicted number of active clusters and rates of abandonment by the DSS are based on highly conservative parameters. The DSS predicts growth of a population over time poorly, but is more useful for simulating population at recovery and determining how that population persists and interacts with other populations. The LEA/POM provides more accurate predictions of population growth over time, but is incapable of simulating complexities such as RCW translocation.

One of the conservative aspects of the DSS is its inability to reapportion habitat over time as new clusters are added to the landscape. The RCW Recovery Plan (USFWS 2003) requires a minimum of 120 acres of foraging habitat surrounding the center of a cluster. The DSS does not allow a new cluster to form within a 0.5-mile foraging partition around the perimeter of each

approximately 200-acre partition. In practice, this causes all habitats within the 0.5-mile foraging partition around the perimeter of an active cluster to always be allocated to that cluster, even if the area lies well beyond the minimum 120 acres of foraging habitat required to surround the cluster center. When attempting to model population growth, the DSS produces an unrealistically large gap between active clusters and new clusters, and an excess of habitat for active clusters.

Additionally, the DSS does not allow budding to occur within habitat that has been allocated to an active cluster, when in reality an approximately 200-acre area of habitat would be large enough to support budding. The function that requires 120 acres of foraging habitat between cluster perimeters can be turned off, which will allow clusters to be placed within 0.5 miles of an existing cluster, but budding still does not occur, except on the periphery of the population. This is most likely leading to an underestimation of the potential of a property to support RCW clusters.

The DSS also does not allow RCWs to recruit to or return to a cluster that has been unoccupied for more than 5 years. This does not reflect how recruitment clusters would be treated under intensive habitat and population management that includes translocation. Under MCB Camp Lejeune's management plan, empty recruitment clusters could still be available after 5 years, and would likely be augmented with translocated birds. Due to this constraint, modeled properties must be initialized at full recovery and maximum RCW capacity to ensure that no potential recruitment is lost in the first 5 years.

Finally, the LEA/POM model underestimates RCW recruitment potential by preventing the addition of translocated RCW groups to the landscape. Results from the LEA/POM model provide a rigorous assessment of the potential of a property to allow natural dispersal of RCWs based on its proximity to existing RCW groups, but does not simulate the benefits of translocation. In a realistic management scenario, a number of clusters containing potential future RCW habitat would be managed over time to restore longleaf pine savannas of differing age classes to the landscape. Once several aggregated clusters have matured to at least 60 years in age, managers would translocate RCWs into clusters during the same general time period, ensuring optimal dispersal opportunities. RCWs would not be translocated to a cluster at a time and location based solely on the fact that habitat has matured to 60 years of age. In LEA/POM simulations, clusters become available for natural dispersal from neighboring properties during each year that habitat matures to 60 years of age in a cluster, regardless of cluster proximity to other active clusters. The latter scenario of natural dispersal with no strategic spatial planning or translocation would result in less successful dispersal and poorer viability of RCW groups on a property over time than in the former, more realistic management scenario.

2.6.10 Landscape Equivalency Analysis/Pattern-oriented Modeling Baseline and Recovery Landscapes

Although current IB-SEPMs have limitations, they are useful guides in determining the biological function of a property or landscape to the CNCPC population. IB-SEPM results

should not be considered a factual representation of population dynamics, but one of many tools used to predict the ability of a property to support RCWs. Using results from LEA/POM scenarios developed by Bruggeman (2010), MCB Camp Lejeune was able to predict RCW population growth, persistence, and demographic and genetic changes that may occur in the CNCPC population if current RCW recovery plans are followed. After the creation of a current land cover GIS layer, a recovery scenario was simulated using habitat restoration and management data originating from the MCB Camp Lejeune RCW Recovery Plan contained in the MCBCL INRMP (USMC, 2006) and from observational data at Holly Shelter. This data was input into a "Recovery Landscape" model to predict the number of PBGs the Onslow Bight could support and the demographic and genetic variation that may take place over a 100-year future time frame if current management plans are followed. A "Baseline Landscape" simulation was also completed to represent the historical range and probable genetic variation of the CNCPC population prior to habitat loss and fragmentation and to provide a comparison to the Recovery Landscape simulation.

2.6.11 Biological Function Analysis Methodologies

2.6.11.1 Landscape Classification

In 2009, MCB Camp Lejeune began using an IB-SEPM (Bruggeman et al. 2005) to evaluate RCW population demographic and genetic function on selected off-base properties (see description in Bruggeman et al. 2010). The purpose was to evaluate the role of future RCWs to recovery of the designated CNCPC population and its population segments. The modeling process required land classification of the Project Area in its current state.

A GIS lab supervised at University of North Carolina by Dr. Aaron Moody identified eight land cover types using 2001 Federal Emergency Management Agency (FEMA) Light Detection and Ranging (LiDAR) data across a subset of the Project Area. Two classifications of RCW habitat were derived from this analysis using Maxent (Phillips et al. 2004) software to identify locations with forest feature data similar to ground survey data collected in RCW foraging habitat at MCB Camp Lejeune from 1999-2001. Maxent was again used in conjunction with Gap Analysis Program (GAP) land cover data to identify areas across the landscape which most closely resembled recovery standard and managed stability standard habitat characteristics determined by the USFWS (2003). The analysis predicted 3.2 percent of the landscape studied currently contains suitable habitat for RCW recovery (Bruggeman et al. 2010).

2.6.11.2 Baseline and Recovery Landscape Simulations Methodologies

The land cover layer used in Baseline Landscape simulations was derived from a model of pre-settlement plant communities developed by Frost and Costanza (2009). RCW habitat home range was defined as 73 hectares after a thorough literature review of RCW breeding and foraging habitat studies was conducted and analyzed. Cluster centers were restricted to a distance of 400

meters apart to follow USFWS RCW management standards (USFWS 2003). The landscape assessment predicted 48 percent of the study area was historically RCW habitat, containing 3,998 clusters. The 100-year simulation of the Baseline Landscape was initiated with 80 percent of clusters occupied by one breeding pair. Fifty percent of occupied clusters were given one helper male at the beginning of the simulation and age was randomly assigned from a normal distribution with a mean of 4 ± 1 year (Bruggeman et al. 2010).

Age, sex, territory location, and status data from 2009 MCB Camp Lejeune, Croatan NF, and Holly Shelter censuses were used in the "Recovery Landscape" modeling process to initialize and build the populations from over the 100-year time frame. Detailed monitoring data collected through Virginia Tech's bird banding program at MCB Camp Lejeune, a field crew at Croatan NF, and the Conservation Management Institute at Virginia Tech at Holly Shelter were used to determine the initial population size and locations of 732 birds in the Onslow Bight (Table 2-1).

Table 2-1. Initial Population Used for the Recovery Landscape Simulation

Property	Active	PBGs	Helpers[1]	Fledglings	Floaters[2]	Total
MCB Camp Lejeune	82	79	60	122	30	**373**
Croatan NF	54	53	0	103	0	**210**
Holly Shelter	34	34	27	54	0	**149**
Total	**170**	**166**	**87**	**279**	**30**	**732**

[1]Helpers were not counted at Croatan NF in 2009

[2]Floaters are only opportunistically monitored at MCB Camp Lejeune and not monitored at Croatan NF and Holly Shelter

Table taken from Bruggeman 2010

At MCB Camp Lejeune, RCWs at three territories were treated as floaters in 2009 and age was randomly assigned from a normal distribution with a mean of 4 ± 1 year to birds not banded as fledglings. At Croatan NF, 1 helper with a 0.47 probability was added to each PBG to conform to historical accounts. At both Croatan NF and Holly Shelter, no floaters were added to the initial populations and age was randomly assigned from a normal distribution with a mean of 4 ± 1 year (Bruggeman et al. 2010).

MCB Camp Lejeune determined the locations of potential vacant clusters, and based on current habitat conditions, provided modelers with dates by which the majority of longleaf pine in each vacant cluster would be at least 60 years of age under intensive habitat management. All clusters would potentially contain appropriate RCW habitat by 2057 (Bruggeman et al. 2010). Modelers used the dates to determine how many clusters and the years in which they would be designated as available for RCW recruitment in the Recovery Landscape.

At Holly Shelter, four additional vacant clusters were added to the 2009 population of 34 active clusters to simulate the Recovery Landscape. The four vacant clusters are known locations at

Holly Shelter that are believed to be available, but were inactive in 2009 (Bruggeman et al. 2010).

2.6.11.3 Landscape Equivalency Analysis/Pattern-oriented Modeling Methodology

In this application, six model parameterizations (P0, P1, P2, P3, P4, and P5), or IB-SEPMs, were used. Model scenarios were simulated for 100 future years with each simulation repeated 100 times for each year by Monte Carlo iterations.

As previously discussed, the LEA/POM model has many applications, but also has limitations that underestimate the capability of properties in the Project Area to support RCW groups. Because the LEA/POM scenarios modeled all three properties using current population sizes in the Recovery Landscape simulations, the potential benefits of RCW translocation were not incorporated. In a realistic management scenario, habitat in some of the vacant clusters could be restored and populated with translocated RCWs in a spatial arrangement based upon maximum cluster aggregation across the property. In this more realistic scenario, RCW PBG establishment would increase at a greater growth rate than LEA/POM model scenarios suggest. More detailed information about LEA/POM methodology can be found in Bruggeman et al. (2010).

2.6.11.4 Findings and Conclusions of Biological Function Modeling

Using the most accurate predictions by the model where all six parameterizations satisfied all POM filters, the simulation estimated the CNCPC population recovery goal of 350 PBGs would be met in 100 years, except in one parameterization scenario, P4, in which the median population size was predicted to conclude in 2108 with 334 PBGs (Bruggeman et al. 2010; Appendix B-1).

Modeling to estimate demographic and genetic function of the CNCPC population revealed that the Baseline Landscape, a landscape unaffected by habitat loss, may have produced a population among the three properties with $H_S \approx 0.71$ (Appendix B-2), $D_{ST} \approx 0.29$ (Appendix B-3), and $F \approx 0.05$ (Appendix B-4). In contrast, the six parameterizations in the Recovery Landscape simulations predicted final values of H_S between 0.64 and 0.66 (Appendix B-2); D_{ST} between 0.32 and 0.34 (Appendix B-3); and F between 0.12 and 0.145 (Appendix B-4). The differences between these Baseline and Recovery Landscape values provide a quantification of the effect of habitat fragmentation.

The results of LEA/POM modeling suggest if current management plans are followed at MCB Camp Lejeune and current habitat is maintained at Croatan NF and Holly Shelter, CNCPC population size will reach recovery goal standards; however, the population is not currently and is not predicted to function demographically and genetically over the next 100 years. In a RCW pedigree analysis study of kinship coefficients, Daniels and Walters (2000) reported breeding pairs with a kinship coefficient ≥ 0.125 produced 44 percent fewer fledglings than unrelated pairs. Because kinship coefficient of parents equals the inbreeding coefficient of fledglings

(Bruggeman et al. 2010), inbreeding rates found in the Recovery Landscape simulations of the CNCPC population (i.e., 0.12 to 0.145) suggest potentially improper genetic function.

Additionally, the LEA/POM models were built under the assumption that all RCWs were unrelated at the beginning of the study because no actual genetic data exists for the CNCPC population. Given this assumption, the actual inbreeding coefficient is likely even higher than represented in models (Bruggeman et al. 2010). Higher H_S and D_{ST} rates in the Recovery Landscape simulations compared to the Baseline Landscape simulations further support the assertion that the CNCPC population is demographically and genetically unsustainable as currently managed.

2.6.12 Conclusion of Current Biological Function of Coastal North Carolina Primary Core Population

Analysis using the new population modeling techniques supports the possibility that the CNCPC sub-populations may not be functioning as a "single biological unit", a possibility that was mentioned in the RCW Recovery Plan (USFWS 2003). Models of future recovery scenarios in which current management plans are followed and habitat is maintained on the properties that RCWs current inhabit predict the population may reach 350 PBGs in 100 years if no management changes are altered. But, spatial modeling also predicts a steady increase in inbreeding and genetic divergence among breeding groups as well as a decline in heterozygosity within breeding groups over a 100-year future time frame (Bruggeman et al. 2010).

The RASP has the potential to return biological function to the CNCPC population by restoring, protecting, and managing potential RCW habitat in perpetuity in strategic locations on the landscape. Budding or pioneering may occur as habitat is restored and protected in close proximity to large existing active clusters. Clusters would be restored in a spatial arrangement which enhances aggregation. Where adjacent property is not available, dispersal corridors can be created through the restoration and protection of appropriate habitat that links clusters across the landscape.

The RCW Recovery Plan (USFWS 2003) requires that "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". The Plan recommends the following actions to accomplish recovery goals: "(1) application of frequent fire to both clusters and foraging habitat, (2) protection and development of large, mature pines throughout the landscape, (3) protection of existing cavities and judicious provisioning of artificial cavities, (4) provision of sufficient recruitment clusters in locations chosen to enhance the spatial arrangement of groups, and (5) restoration of sufficient habitat quality and quantity to support the large populations necessary for recovery." These habitat and RCW management actions can be integrated into the standard requirements for all potential RASP properties.

Habitat restoration and protection is a central aspect of RASP properties, but translocation of RCWs from other populations is also a management option through the RASP. As new habitat is made available, more birds can potentially inhabit and breed in the Project Area. Based on the findings of the LEA/POM models, the introduction of new RCW genes through translocation may be essential to improving demographic and genetic function in the CNCPC population.

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3.0 PROPOSED ACTION (GEOGRAPHIC EXPANSION OF RED-COCKADED WOODPECKER HABITATS IN THE COASTAL NORTH CAROLINA PRIMARY CORE POPULATION)

The USMC proposes a programmatic process to work with public and private partners in the establishment of new subpopulations of RCW and/or additions to current subpopulations within the Project Area. The purpose of the RASP is to enhance the ability of the core population to counteract threats of environmental, demographic, genetic and catastrophic stochastic events, thereby maintaining long-term viability for the species. Establishing new, viable subpopulations and/or demographic functionality in the primary core population will also help provide the flexibility required to allow MCB Camp Lejeune to lower its RCW recovery goal and meet mission requirements in the future. RCW recovery and the military mission goals can be met by initiating a program that identifies, evaluates and conserves properties with the potential to establish new groups or populations of RCW within the Project Area.

All conservation measures described as part of the proposed action will be implemented as described in the May 2005 USFWS Memorandum: *Implementation Procedures for Use of Foraging Habitat Guidelines and Analysis of Project Impacts under the Red-cockaded Woodpecker (Picoides borealis) Recovery Plan: Second Revision*. Temporally and spatially explicit analyses will consider impacts to (1) the foraging partition; (2) the group; (3) the neighborhood; (4) population; and/or (5) recovery unit. Results will be analyzed to determine the potential impact on the demographic functionality and net growth of the CNCPC population.

3.1 POTENTIAL BENEFITS

3.1.1 Increase in Population Size within "Subpopulations"

As current and potential RCW habitat is strategically selected and those properties are protected by the RASP process, the RCW population size will increase within the Project Area. Using methodologies which improve the spatial arrangement of clusters in the CNCPC population will increase aggregation, and in turn, improve demographic functionality. Within each subpopulation, if new habitat becomes available within 2 miles of an existing cluster, budding may occur as dispersing juvenile and helper males move to assume breeding vacancies. Juvenile females in clusters as far as approximately 3.7 miles away may disperse into the new habitat and begin breeding (Daniels 1997; Walters et al. 1988). Protecting properties adjacent to or within short distances of those RCW PBGs currently utilizing low quality habitat can potentially allow the expansion of their home range (Hooper et al. 1982; DeLotelle et al. 1987; Bowman et al. 1997; Hardesty et al. 1997; Walters et al. 2000a, 2002a).

3.1.2 Linking "Subpopulations"

MCB Camp Lejeune will use landscape modeling results to help determine the optimal arrangement of properties with potential RCW habitat and high connectivity between them. Protecting properties with few or small habitat gaps between them will ensure the highest possible dispersal rates and genetic exchange between properties. Female RCWs, in particular, are sensitive to forest habitat gaps and will change the direction of dispersal when gaps are present (Kessler and Walters, unpublished data). RCW managers may increase potential dispersal by managing these "stepping stone" properties between subpopulations to create habitat corridors. If protection can be attained in these areas, particularly between MCB Camp Lejeune and Holly Shelter, isolated subpopulations may eventually be connected, increasing overall CNCPC population viability.

3.1.3 Minimize Threats to Population Viability

As protected properties are managed for RCWs through the RASP, habitat quality will improve over time, yielding larger, older longleaf pine with optimal basal area density and a fire-maintained, diverse herbaceous ground cover. Once RCWs begin occupying new properties, group size, fecundity, or both may increase as the habitat quality improves (Conner and Rudolph 1991a; Rudolph and Conner 1994; Hardesty et al. 1997; Engstrom and Sanders 1997; James et al. 1997, 2001; Walters et al. 2002a).

Translocation of RCWs is possibly the most beneficial aspect of the RASP to CNCPC population viability. The combination of increased habitat availability and translocated RCWs on new properties will diversify the gene pool and increase the number of potential breeding groups across the landscape. These changes will likely decrease the adverse effects of inbreeding, and impacts from stochastic demographic, environmental, catastrophic, and genetic events.

3.1.3.1 Demographic Stochasticity

According to RCW modeling completed by Letcher et al. (1998), populations with less than 100 clusters that are not highly aggregated decline and may not be viable over time (USFWS 2003). Under this assumption, only the highly aggregated clusters in eastern MCB Camp Lejeune and northern Croatan NF could potentially resist demographic stochasticity for 100 years and the highly aggregated subpopulation on Holly Shelter may resist for about 20 years.

Modeling by Bruggeman et al. (2010) revealed an overall demographic function of the CNCPC RCW population for 100 years. The population was projected to reach 350 PBGs in five of six parameterizations, and 334 PBGs in one of the parameterization results; however, genetic functionality computations suggested substandard inbreeding coefficients, even though all birds were assumed unrelated at the beginning of simulations.

As budding occurs in subpopulations due to newly available habitat, demographic stochasticity will decrease and aggregation will increase. Adding translocated RCWs to the landscape in strategic locations will increase the chances of budding and pioneering even more, further decreasing demographic stochasticity.

3.1.3.2 Environmental Stochasticity

Results from an IB-SEPM developed by Walters et al. (2002b) indicate that the effect of environmental stochasticity on RCW populations is relatively minimal and closely follows the same results that Letcher et al. (1998) reported for demographic studies of the same landscape. The researchers noted a strong positive effect on population viability with more aggregated clusters and a large influence on breeder mortality from male helpers. The transition of helpers to breeders from one territory to another nearby cluster helped balance the effects of environmental stochasticity and related breeder mortality rates. As is also true in other measurements of RCW population viability, the effects of environmental stochasticity can be lessened as more clusters are aggregated closely together on the landscape through the RASP. Closer territories create opportunities for male helpers to transition to new clusters and become breeders (Walters et al. 2002b).

3.1.3.3 Catastrophes

The primary catastrophic events most likely to impact RCWs in the Project Area are hurricanes. The high force winds of hurricanes can destroy cavity trees and cause substantial loss of RCW territories and resultant mortality. The RCW Recovery Plan (2003; Hooper and McAdie 1995) recommends three actions to address the threat of hurricanes to RCW population viability. First, multiple populations broadly distributed across a wide geographic region with many inland populations have an increased chance of survival when impacted by a hurricane. Second, managers can reduce hurricane-related mortality within individual populations by implementing habitat rehabilitation in the affected area following the catastrophic storm. Lastly, managers can maximize wind resistance in forest stands where individual populations at most risk from hurricanes occur.

The RASP will result in a form of preemptive management which will increase survivorship of the CNCPC population in the event of a catastrophic hurricane by increasing the number of RCW subpopulations across the region. As new clusters are formed on RASP properties, the geographic distribution of the CNCPC population will expand, protecting the overall population from devastation if a hurricane were to greatly impact one portion of the Project Area, but leave another area intact. By broadening their distribution, the RASP will make the CNCPC population more resistant to decreased population viability from hurricane destruction.

Southern pine beetles pose the second greatest risk to RCW population viability; however, loss of cavity trees in the Project Area Bight can be relatively easily mitigated through proper habitat management and the installation of artificial replacement cavities. All properties included in the

RASP will be required to manage habitat appropriately, which includes controlling southern pine beetle outbreaks which threaten clusters. The RASP also encourages the growth of longleaf pine trees, which are far more resistant to southern pine beetle outbreaks than loblolly pine.

3.1.3.4 Genetic Drift and Inbreeding

With no recovery properties in the Onslow Bight currently supporting 100 or more PBGs, it is likely that if management plans do not change, the CNCPC population will be affected by genetic drift and inbreeding depression. In IB-SEPM studies, Daniels et al. (2000) found that even populations of 100 clusters were only marginally stable over a 50-year simulated time period. Models by Bruggeman et al. (2010) resulted in predicted inbreeding coefficients for the CNCPC population within a poor range, according to pedigree analysis studies by Daniels and Walters (2000). New genetic variation is necessary in the CNCPC population to ensure fledgling success and long-term viability. Connection of subpopulations by 0.5 to 2.5 migrants per year can produce the same amount of genetic variation as one population of the same size as both subpopulations combined (USFWS 2003).

The introduction of new genetic material into the CNCPC population is imperative to overall viability. RCW population viability and function can improve with the addition of new RASP properties and translocated RCWs. If habitat is restored and managed for RCWs and new individuals are translocated to strategic locations on the landscape in highly aggregated clusters, genetic stochasticity and other negative dynamics can be avoided over time.

3.2 BIOLOGICAL FUNCTION ANALYSIS METHODOLOGIES OF ADDED PROPERTIES

The objective of the USFWS and MCB Camp Lejeune is to identify spatially suitable off-base properties and RCW habitat that, with a future increase in RCWs, will constitute larger, more viable and less vulnerable populations than the CNCPC population segments on MCB Camp Lejeune, Holly Shelter, or Croatan NF. To evaluate the role of future RCWs on selected off-base properties in the recovery of the designated CNCPC population and its population segments, MCB Camp Lejeune will utilize results from several spatial analyses. First, the installation will examine the size, location, the current and potential nesting and foraging habitat, and the current ownership of properties across the landscape by utilizing results from GIS-based habitat analyses. Potential management scenarios based on previous land use and historic and current RCW use of a property will be of high importance in property assessments as well.

If the property remains a candidate for inclusion in the RASP after this initial evaluation, an IB-SEPM RCW DSS will be utilized to gain a preliminary understanding of population growth, persistence, function, and dispersal patterns. Any property that the DSS predicts will contribute to biological function of the CNCPC population will then be analyzed using a second, more rigorous population model, the LEA/POM (Bruggeman et al. 2005).

The LEA/POM method differs from the DSS by combining six different IB-SEPM parameterizations, POM, and genetic models to determine RCW abundance, genetic drift, local extinction, and migration shifts in a dynamic and fragmented landscape. Based upon predictions from both population models and other evidence of the suitability of a property, such as historical use by RCWs, the presence of currently or potentially suitable RCW habitat, and the potential effects of management techniques, such as translocation of RCWs in spatially aggregated clusters, the USFWS will determine whether a property contributes to the biological function of the CNCPC population. It should be noted that there may be some projects that will not require LEA/POM modeling in addition to the DSS to ascertain biological function, for example a property with excellent current or potential habitat that is immediately adjacent to an existing RCW population.

3.2.1 Red-cockaded Woodpecker Habitat Assessment

To assess the level of biological function of individual properties, a spatially-explicit habitat analysis was conducted using various GIS software packages and analysis techniques. First, all parcels of greater than or equal to 200 acres were extracted from the landscape to exclude parcels which were not large enough to meet RCW Recovery Plan cluster size standards (USFWS 2003). Then, current and potential longleaf pine habitat was identified through the development and reclassification of three landscape characteristics GIS layers: current vegetation, potential vegetation, and RCW cluster proximity.

Current vegetation data were based on the southeast GAP land cover dataset (BaSIC 2008), and the U.S. Geological Survey (USGS) LANDFIRE Existing Vegetation Type datasets (LANDFIRE 2011). The Existing Vegetation Type data layer represents the current distribution of the terrestrial ecological systems classification developed by NatureServe for the Western Hemisphere. Current physical characteristics GIS layers were developed using LiDAR data collected by the Division of Emergency Management North Carolina Floodplain Mapping program. FUSION (USDA FS 2011) was used to analyze the LiDAR data and convert it into a raster format of 100x100-foot grids. Analysts then acquired canopy height, canopy cover and two indicators of understory density using the LiDAR dataset. Current conditions were refined by excluding high density areas of land development using a Wildland-Urban Interface GIS layer.

The potential vegetation GIS layer was created by evaluating and analyzing a “pre-settlement vegetation class” dataset developed by Frost and Costanza (2009) and the LANDFIRE Biophysical Settings (LANDFIRE 2011) dataset. The pre-settlement dataset represents vegetation that likely existed prior to European settlement. Classification of county soil series to pre-settlement vegetation class was completed by Cecil Frost (University of North Carolina), and GIS mapping work was completed by Jennifer Costanza (The Nature Conservancy). The Biophysical Settings data layer represents the vegetation that may have been dominant on the

landscape prior to Euro-American settlement. Vegetation attributes are based on both the current biophysical environment and an approximation of the historical disturbance regime.

A RCW cluster proximity analysis was completed using RCW cluster locations data provided by the NCWRC and parcel data acquired from the various counties within the Project Area. Habitats closest to historic or current RCW clusters on the landscape were classified as the highest quality habitat in this dataset.

All three landscape characteristics GIS layers were reclassified by ascending numbered category to represent a range of habitat quality in each layer from lowest to highest quality. Then, the three reclassified layers were overlaid and parcels with the best quality RCW habitat on the landscape were extracted. Lastly, these layers were compared with a species guild richness change layer developed by Dr. Alexa McKerrow of NCSU. This layer identifies the change in the ability of current vegetation, from pre-settlement to present, to support the species of a particular guild. Areas predicted to have maintained the ability over time to support most or all of the species in the wet longleaf and dry longleaf pine species guilds were classified as the highest quality RCW habitat.

The results of this landscape analysis provided MCB Camp Lejeune with new options to remotely assess a property's potential to support RCWs. The landscape analysis layers provide the user with a tool to visually evaluate a property's potential using GIS. With thematic shading applied to the analysis layers, the varying degree of RCW habitat quality on properties in the Onslow Bight is readily apparent (Figure 3-1).

3.2.1.1 Determination of Red-cockaded Woodpecker Dispersal Corridors

The landscape analysis of current and potential RCW habitat is not only useful in prioritizing potential RASP properties, but it also displays RCW dispersal corridors. The spatial arrangement of properties currently inhabited by RCWs and potential RASP properties is extremely important to the success of the CNCPC population; however, the amount of habitat that can be managed to support RCW clusters is limited by habitat connectivity with adjacent protected properties. For properties inhabited by active RCW clusters to remain occupied over time, dispersal to other subpopulations must occur by way of corridors.

In a study by Kesler and Walters (unpublished data; Bruggeman et al. 2007), male RCWs did not differ in dispersal behavior based on vegetative composition of corridors. Female RCWs preferred previously used paths to unused paths and were less likely to cross gaps in forested habitat as gaps increased from 150 meters to 630 meters. Results suggested general avoidance of gaps by female RCWs was inconsistent, but more notable in avoidance of water gaps versus terrestrial gaps.

Using the landscape analysis of RCW habitat and the results of the Kesler and Walters (unpublished data) study, MCB Camp Lejeune can determine the location of dispersal corridors

in the Project Area. Through spatial analysis, those corridors that can provide the best connectivity between current recovery properties and potential RASP properties with the fewest water gaps can be identified.

3.2.2 Current and Potential Habitat Assessments of Individual Properties

MCB Camp Lejeune will be equipped to look for properties with the highest quality RCW habitat and the best connectivity by utilizing the Onslow Bight Landscape Analysis(USMC, 2010) A parcel layer produced in the analysis can be utilized to identify a particular parcel of interest or rank and query unknown parcels. MCB Camp Lejeune will be able to query and select parcels based on ownership, acreage, and percentage values of each landscape characteristic evaluated.

Once a property of interest is selected for further analysis, more GIS data can be utilized to determine suitability for RCWs. Data such as on-site forest inventories, USDA GIS soil types, National Wetland Inventory, Onslow and Pender County contours, and historic and current aerial imagery can be overlaid on particular properties to refine analyses of a property's potential to support RCW habitat. With finalized RCW habitat predictions completed, analysts will then define the perimeters of habitat partitions that average approximately 200 acres across the property.

3.2.3 Modeling of Red-cockaded Woodpecker Population Dynamics with Additional Properties

MCB Camp Lejeune will use two IB-SEPM methods to evaluate RCW population growth potential and demographic and genetic function on selected off-base properties. The first approach will use the RCW DSS developed by Walters (2005) and collaborators (See Section 2.6.2). Different scenarios of added off-base habitat locations will first be modeled using the DSS with RCWs at maximum capacity on each property. The mean group size of clusters that form within habitat partitions in the Project Area can vary from 2.4 RCWs per group under poor conditions to 2.9 under optimal conditions, such as those at MCB Camp Lejeune (Walters et al. 2011). Modeling properties with appropriate habitat at full capacity provides an estimation of the number of viable PBGs a property can maintain under optimal conditions. Any deficiency or failure of off-base property populations to persist at maximum capacity would be a strong indicator of inadequate function since smaller more vulnerable populations would actually be required to grow over time to attain maximum abundance.

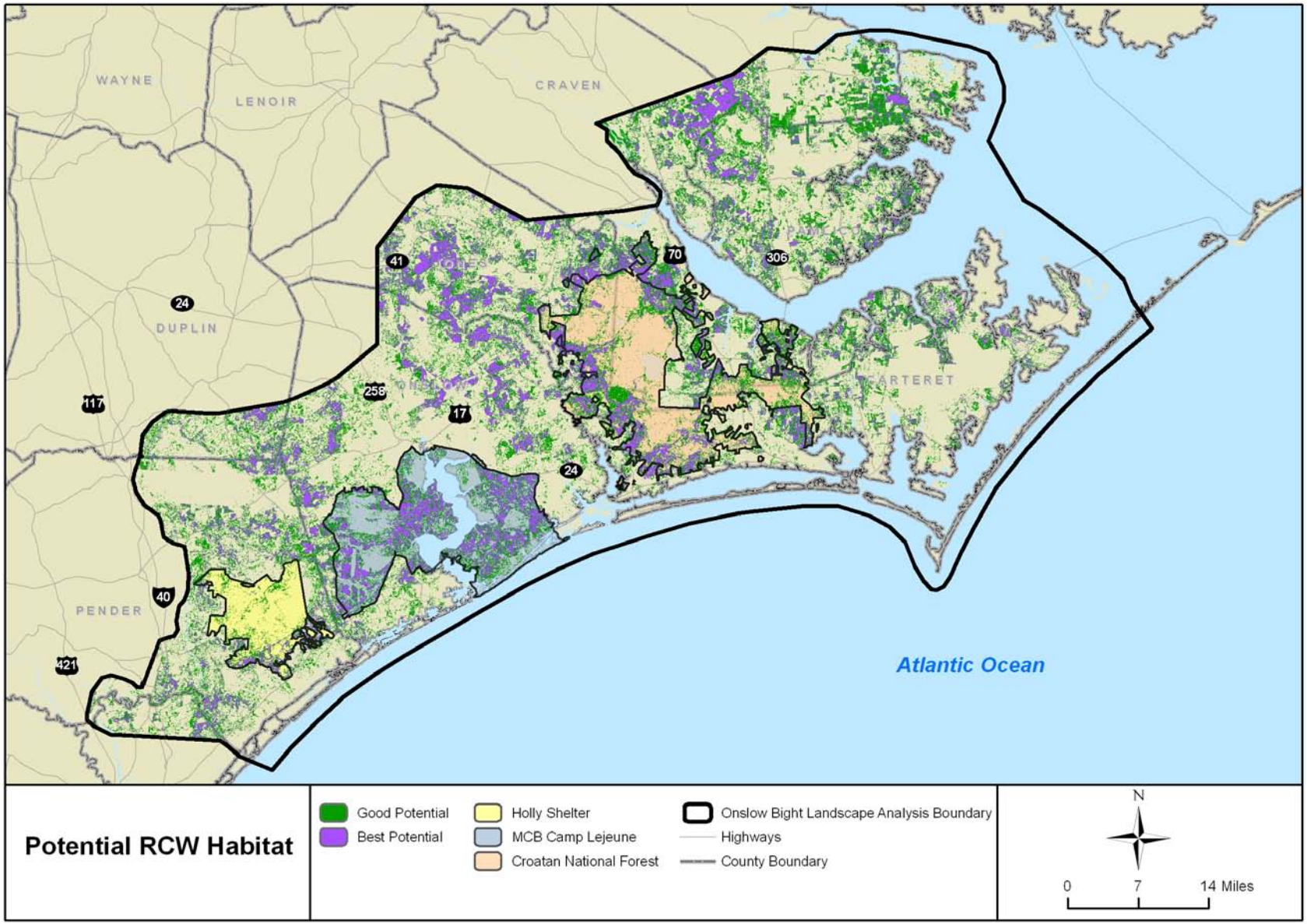

Figure 3-1. Results of Landscape Analysis Depicting Good and Best Potential RCW Habitat.

If DSS results predict PBGs will occupy an off-base property, a second IB-SEPM will be used to refine the analysis. Although the DSS is a useful tool, inherent limitations of the model require the use of the LEA/POM method (See Section 2.6.2 of this document), which is a more rigorous process that can reduce uncertainties in model parameters. The DSS has limitations which may skew cluster recruitment results and it cannot address genetic dynamics across diverse habitats over time.

In contrast to the DSS analyses, LEA/POM model scenarios will be initiated at year 0 (2009) under actual current conditions of RCW group occupancy on each property; with vacant recruitment clusters on unoccupied off-base properties of interest and with active clusters populated with known numbers and locations at MCB Camp Lejeune, Holly Shelter, and Croatan NF. The six model parameterizations (P0, P1, P2, P3, P4, and P5) or IB-SEPMs that produced patterns similar to those recorded at MCB Camp Lejeune will be used in simulations. The time to habitat maturation can be estimated within recruitment clusters previously identified in the determination of partition locations on the property of interest. Clusters will become available for recruitment in the simulation during the years when pine habitat is expected to reach approximately 60 years of age within the majority of a partition area. Population growth will be simulated for 100 future years from 2012 to 2112 with 100 Monte Carlo iterations. Establishment of RCW PBGs in clusters will be totally dependent on natural dispersal from active clusters at MCB Camp Lejeune, Holly Shelter, and Croatan NF to recruitment clusters as they become available. If a property is predicted to populate with PBGs and improve demographic and genetic function of the CNCPC population when modeled using the LEA/POM method, it may be further considered for RCW management by MCB Camp Lejeune.

3.2.4 Determination of Potential Breeding Groups

Because the success of RCW populations is more commonly determined by the number of PBGs with helpers and the spatial arrangement of clusters than individual RCW survival and reproduction, the value of a property to the CNCPC population will be evaluated, in part, by the number of potential PBGs it may support. The DSS predicts RCW group size across all properties for each year of simulations but the number predicted to occur on each property is not presented to the user; however, the LEA/POM produces a data output for each property which provides the arithmetic mean number of individuals in each potential cluster for each year across the 100 Monte Carlo iterations. Mean values of 0 for a given year for a particular cluster indicate it was vacant during all 100 iterations. In evaluations of the potential for a property to support RCWs, clusters with a mean group size of two during a reference year will be interpreted to contain one PBG. Each multiple of two in mean group size for any given year in a cluster will represent one PGB (e.g., a mean group size of 4 = 2 PBGs). It is possible for a mean group size of two or more in a particular cluster and year to include a group of less than two birds (not a PBG) during one or more of the 100 iterations, but this will not be a prevailing or frequent

condition, and therefore this calculation is considered sufficient. A mean group size greater than one will be defined as an active cluster occupied on average by at least a single-bird.

The following information can also be calculated with LEA/POM output data produced in simulations of the potential of a property to support RCWs:

- the number of years in a simulation in which RCW dispersal occurs but no RCWs remain stationary in a cluster (i.e., "Years with Movement") will be calculated by adding the number of years mean group size is greater than zero
- the number of years habitat in each cluster is predicted to be available for RCW inhabitance ("Years Available") will be calculated by subtracting the first year the majority of habitat is at least 60 years of age from the last year of simulations
- "Frequency of Movement" will be calculated by dividing "Years with Movement" by "Years Available"
- the number of years in which a cluster is active (i.e., "Years Active") will be defined as the number of years in which the mean group size is greater than or equal to one
- the number of years in which a PBG is present in a cluster (i.e., "Number of PBG Years") will be defined as the number of years in which the mean group size is greater than or equal to two
- "Relative Frequency of PBG Years" in a cluster will be calculated as "Number of PBG Years" divided by "Years Available"
- "Average Group Size at Year 100" will be available in data output for each cluster
- "Number of PBGs at Year 100" will be calculated by dividing the "Average Group Size at Year 100" by two and rounding down.
- Average annual geometric growth rate of PBGs on a property will be computed for each parameterization as:

$$r = \sqrt[t]{PBGf / PBGi} - 1$$

where t is the time (in years) from establishment of the first PBG at any recruitment cluster to the first year when one PBG has been established on all clusters; PBGf is the mean group size at the first year when any cluster establishes a PBG. If more than one cluster establishes the first PBG in the same year, the largest group size will be used. PBGi is 1.

3.3 CONCLUSION OF BIOLOGICAL FUNCTION OF GEOGRAPHIC EXPANSION ON COASTAL NORTH CAROLINA PRIMARY CORE POPULATION

Sophisticated population modeling techniques which predict future RCW use of properties are valuable in an assessment of function within the CNCPC population, but users must recognize models as only one component of a full property evaluation. Realistic potential management scenarios, including beneficial spatial arrangement of recruitment clusters and RCW translocation, and the historical management of the property and use of it by RCW groups must also be considered. Even if a property is not predicted to support a number of PBGs in model simulations, use of these management techniques could substantially improve the potential of the property.

DSS and LEA/POM analyses are based on a conservative partition size requirement of 200 acres, on average per property, and various inherent modeling limitations exist in both models (See Section 2.6.9.1). Although both models have been validated and verified and provide quantifiable guidance in the evaluation of property, all factors contributing to potential RCW presence were not included in the models. A smaller average partition size for each property and more flexibility in the models to simulate realistic management scenarios, such as translocation, could increase the number of potential clusters on properties. Model results are valuable in decision-making, but, all factors, including historic presence of RCWs and possibilities for aggregated cluster arrangement of translocated RCWs must also be heavily considered in property assessments.

3.4 STAKEHOLDER COOPERATION AND COORDINATION

The RASP is a voluntary program that at a minimum requires participation by two federal agencies (USMC and USFWS) and a landowner. The landowner may be a state or municipal government, a non-governmental organization (NGO), a business entity, or a private landowner. In some cases, especially those involving land acquisition, there may be other parties involved in the funding, transfer, and/or purchase of the property. Effective coordination will be very important to a successful program. MCB Camp Lejeune will have primary responsibility for coordination of the RASP. Effective and timely coordination with other agencies and NGOs is important because the legal and financial agreements are complex, and land with important RCW habitat may potentially be involved in multiple conservation programs such as Safe Harbor, North Carolina Department of Transportation mitigation projects, etc.

Fortunately, a well-established group called the North Carolina Onslow Bight Conservation Forum (NCOBCF) already exists for coordination of land conservation programs, and the membership includes most of the agencies and organizations actively working conservation and endangered species programs within the geographic area of the CNCPC. By utilizing the NCOBCF, the RASP can assist the USFWS, other federal agencies, and their partners to achieve more effective implementation of the RCW Recovery Plan by using conservation tools such as

conservation easements, fee title acquisition, state property dedications, and ownership by third parties. The NCOBCF RCW subcommittee may assist the USFWS and MCB Camp Lejeune in the selection and evaluation of properties to be included in the program.

Formal coordination between agencies will, in most cases, be initiated by MCB Camp Lejeune and will normally be associated with the five steps described in Section 1.5.4. For example, when a Biological Function Analysis has been completed on a tract being considered for inclusion in the RASP, the analysis will be sent with a cover letter to the USFWS, requesting review and concurrence.

3.5 AGREEMENTS TO PROTECT RED-COCKADED WOODPECKER HABITAT IN PERPETUITY

Properties that meet the biological function requirement are eligible to be considered as part of a project to contribute to the recovery of the CNCPC population and reduce the recovery goal of MCB Camp Lejeune. Final approval by the USFWS to reduce the MCB Camp Lejeune recovery goal will be contingent on legal and financial documents that define and assign responsibilities, provide for protection of habitat in perpetuity, and define and finance management activities. The documents are generically referred to as "agreements" but may include cooperative agreements, memorandums of agreement/understanding, transfers or sales of real property, restrictive or conservation real estate easements, contracts, escrow accounts, letters of credit, endowments and others. The actual agreements used may depend on the organizations or entities involved and the particular details of the project. For example, some projects may involve the sale and transfer of property and some may only provide for perpetual habitat preservation and management with the property owner retaining title. Agreements also define responsibilities and requirements for management and monitoring activities. In most cases, a management and a monitoring plan will be an exhibit to an agreement. Management and monitoring plans will be reviewed and approved by the USFWS as part of their review of the agreement.

Conservation banks developed under the USFWS Conservation Banking Guidance that also meet the requirements of this PBA will also be considered eligible projects for contributing to CNCPC population recovery and reduction of the MCB Camp Lejeune recovery goal. Typical information to be provided in a conservation banking agreement is included in Appendix C.

3.5.1 Financial Assurances

Agreements will identify and include a requirement for adequate funding to provide for the RCW recovery project's perpetual operation, management, monitoring, and documentation costs. For projects where the federal government will not be directly responsible for implementation for RCW management activities, an endowment will be the normal approach to providing funding for management. The size of an endowment will depend on certain factors that could include the

amount of habitat associated with each RCW cluster, the land management activities, the amount or degree of habitat restoration needed, the "risk" of such restoration failing over time, the rate of inflation, and the capitalization rate. It may also be possible for the RCW recovery project to support certain agreed upon revenue generating activities (e.g., bird watching, hiking, grazing), if these activities do not conflict with the conservation goals of the project or the intent of the compensation for impacts (e.g., in certain ecological situations, grazing may be a needed management tool). Such monies may be held in escrow or other long-term money management accounts to insure they are available when needed.

Although for most projects the primary type of financial assurance will be a non-wasting endowment, in some cases other types of financial assurances may be acceptable including but not limited to: performance bonds, irrevocable trusts, escrow accounts, casualty insurance, letters of credit, legislatively enacted dedicated funds for government-operated projects, or other approved instruments.

A management plan will be prepared to help determine the appropriate amount of funding. The management plan will include the activities necessary to implement the biological goals and objectives. Funding for the start-up of the management program normally will be funded separately from the requisite endowment for ongoing actions. These initial costs may include up-front costs to the project owner, including, but not limited to: purchase of the habitat, any enhancements or clean-up required, and property taxes. The amount of funding that will be necessary for the ongoing management program will be clearly articulated in the agreement. Additionally, there may be consultant or legal fees associated with developing and managing the RCW recovery project.

3.5.1.1 Endowment Fund Management

Endowment fund principal amounts must not decrease in value through expenditure or investment strategy. The endowment principal amount is intended to increase in value to keep up with inflation; therefore, a portion of the interest and earnings on the endowment principal balance should be reinvested into the endowment fund as required to adjust the endowment principal using the Consumer Price Index (CPI) adjustment formula or other acceptable criteria. Interest earnings beyond those necessary to provide for endowment principal growth commensurate with inflation should be made available to fund annual management of the project. Endowment fund revenues (including earnings and interest) remaining after the endowment principal is adjusted for inflation that exceed the anticipated annual management expenses of the project should be retained in the endowment fund and made available to fund unexpected expenses and adaptive management needs.

3.5.1.2 Financial Records and Auditing

Agreements will have terms and conditions that require the project sponsor and/or property owner, as appropriate, to maintain complete and accurate records relating to the financial

operation of the project using generally accepted accounting methods, principles and practices consistently applied. The financial operation of the project includes all financial assurances received or expended during the establishment and operation of the project. Agreements shall also provide for auditing of financial records. Records relating to the financial operation of the project will be audited by an independent, licensed Certified Public Accountant and shall submit the auditor's report to the parties of the agreement upon completion.

Agreements will also provide for the right to review and copy any records and supporting documentation pertaining to the performance of the project by the parties to the agreement. The parties will have to agree to maintain such records for possible audit, to allow the auditor(s) (including state and/or federal auditors when appropriate) access to such records during normal business hours and to allow interviews of any employee or representative who might reasonably have information related to such records.

3.5.2 Conservation Easement

A conservation easement will be part of the agreement when the project involves the protection and management of property that is not already protected and managed by the state or federal government, or in cases where the federal government seeks an interest in a property for the purposes of endangered species recovery and/or other purposes such as compatible land use. The conservation easement will serve to provide a permanent, enforceable mechanism for preserving the habitat on the property in such condition to facilitate management for RCW. Another purpose of the easement is to provide a "federal remedy" should the landowner not fulfill the requirements of the easement. The easement will contain language giving the federal government rights to correct deficiencies in RCW management that result from violations of the terms of the easement, should they occur. An example of a conservation easement developed to facilitate RCW management is included as Appendix D.

3.5.3 Fee Title Acquisition

Fee title acquisition of land may be required for some projects. This may be done in conjunction with a conservation easement or instead of, depending on the situation. The most likely scenario is that land with potential to manage for RCW is acquired from a willing seller by the state or a private organization. A conservation easement may then be sold to the Department of the Navy (DoN) as a way of permanently protecting the habitat and recouping some of the investment in the land. A separate agreement and financial arrangement between the parties, as described above would then complete the project.

Land acquisition, including the purchase of easements, by the DoN is conducted under differing authorities depending on the cost and purpose of the acquisition. Acquisitions costing less than $750,000 may be done under a commander's local authority. Acquisitions over $750,000 are

usually done as part of the Military Construction (MILCON) authority and must be approved by Congress. Title 10 USC 2684a allows DoD to acquire land or interests in land from willing sellers when done as part of an agreement with a state, municipality or eligible conservation organization. The DoN calls these agreements "Encroachment Partnering" agreements and the process is most commonly used to maintain land uses that are compatible with military activities of a nearby installation or military airspace that overlays the property to be acquired. All acquisitions are done with approval of higher headquarters and in accordance with Navy real estate policies regarding appraisals, title work, surveys, and other due diligence requirements.

3.5.4 State Property Dedications

In some instances, properties being considered for inclusion in the RASP may be protected in accordance with the North Carolina statute (G.S. 113A-164) and regulations (15A NCAC 12H) related to "Dedication of Nature Preserves". State lands owned that are "dedicated" are protected from uses that are not compatible with conserving the natural resources of the property in question:

> "Lands dedicated for nature preserves pursuant to this Article are held in trust by the State for those uses and purposes expressed in this Article for the benefit of the people of North Carolina. These lands shall be managed and protected according to regulations adopted by the Secretary. Lands dedicated as a nature preserve pursuant to G.S. 113A-164.6 may not be used for any purpose inconsistent with the provisions of this Article, or disposed of, by the State without a finding by the Governor and Council of State that the other use or disposition is in the best interest of the State. (1985, c. 216, s. 1.)"

For purposes of the RASP, state owned properties that have been dedicated will be considered to have met the requirement that the property be "preserved in perpetuity"; however, this will not prevent the federal government or another entity from acquiring an interest such as a conservation easement on the property if it is determined by the federal government or other entity that such instrument is required to protect their rights or interests in the land.

More details on state property dedications can be found in Appendix E.

3.5.5 Development of Red-cockaded Woodpecker Management/Monitoring Plans

3.5.5.1 Management Plans

Each off-base property will be required to develop a management plan approved by MCB Camp Lejeune and the USFWS prior to a final agreement. The goal of any management plan will be to restore and or maintain good-quality RCW habitat, as defined in the most recent revision of the USFWS RCW Recovery Plan. Plans should address restoration needs, timber management schemes, and prescribed burning. Plans should follow the silvicultural guidelines for public land

outlined in the RCW Recovery Plan, and may consist of low-intensity management, uneven-aged management or two-aged management, or a combination of these methods. Because of the varying missions of potential off-base properties, this document will not spell out in detail exactly what a property management plan should include, as long as it promotes good-quality habitat and minimizes the time to occupation by RCW. Plans may allow for timber sales that are consistent with the RCW Recovery Plan. Management plans should include prescribed burning of RCW habitat on an average of every 3 years, with the majority of the burning taking place in the growing season.

Depending on the current condition of the property, a management plan may require extensive habitat restoration, including the establishment of longleaf pine or suitable understory. Where significant restoration is required to make the property suitable for RCW, the management plan will include a restoration phase and a management/maintenance phase. On properties with less need for restoration, the restoration and management/maintenance phases can occur simultaneously or overlap. On properties with no need for habitat restoration, the plan will include only the management/maintenance phase. The timeframe for the restoration phase will depend on size of the property, the extent of restoration necessary, and whether or not a property can support RCW while habitat is being restored at the same time. In the extreme case, where there is no currently suitable habitat, and no suitable trees (longleaf pine, in most cases) in the ground, the property must be planted in a relatively short amount of time; 5 years would be reasonable in most cases. In cases where some restoration is needed, but there is suitable habitat on site, and/or potential habitat growing toward being suitable, the restoration phase of the plan will emphasize restoration that minimizes the time needed to create suitable foraging partitions or nesting habitat. In all cases, timeframe of the restoration phase should emphasize speed to recovery, in order to create suitable foraging and nesting habitat as soon as is feasibly possible.

3.5.5.2 Population Monitoring

Populations on off-base properties, at a minimum, will be monitored to determine 100 percent of the number of active clusters, and PBGs. Monitoring protocols will follow basic monitoring techniques outlined in the most recent revision of the RCW Recovery Plan. In addition, if the population is actively being augmented through translocation, all RCWs will be color-banded, and group status will be determined for all groups. Monitoring will follow the following protocol:

(a) The activity status of all known RCW clusters will be determined. Status categories to be used are inactive, occupied by a breeding group, occupied by a solitary male, and captured (used for roosting by a bird/s from a group whose primary residence is another cluster).

(b) All active clusters will be checked for breeding activity. Active trees will be visited every 7 to 9 days to check for the presence of a nest. When nests are discovered, nestlings will

be banded 6 to 10 days after hatching, and the group will be followed after fledging to determine which of the banded young fledged.

(c) If part of an ongoing translocation program, all RCWs on the property will be identified from auxiliary markers (color bands). The identity and social status of all group members will be determined by following groups or by censusing groups coming to roost in the evening. Group size and group composition will be recorded. These observations will be used to separate active clusters into those occupied by a breeding group, those occupied by a solitary male, and those that are captured (see b). Any unbanded adult woodpeckers will be captured and marked with USFWS bands and auxiliary bands that will permit subsequent visual identification of individuals.

(d) Whenever population monitoring reveals indicators of new, unknown clusters, such as territorial conflicts in an area where none occurred previously, or the repeated appearance of unbanded birds in a particular area, that area will be surveyed for unknown clusters. Any clusters discovered will be included in all tasks described above.

3.5.5.3 Annual Reporting Requirements

A report summarizing monitoring and other data collected pursuant to Section 3.5.5.2 above, including the number of properties and acreages added to the program each year, summaries of management actions occurring on all properties enrolled in the program, and summaries of RCW monitoring results will be provided to the USFWS each year. The USFWS will review this report and will meet with MCB Camp Lejeune as needed to discuss any issues that may be revealed. It is envisioned that this report will be consistent in terms of format with those already provided by MCB Camp Lejeune regarding their ongoing RCW management, so as to minimize the reporting burden.

3.5.5.4 Calculations of Management Costs

USMC is currently in the process of developing a method and template for use in calculating and comparing management costs. Both short- and long-term costs will be part of the template. Short-costs will normally be calculated for the first 5 years of management but in some cases this time period may be shorter or longer depending on the current condition of the habitat on the property. As discussed previously, short-term costs may be funded separately from long-term costs. Short-term costs may be funded on an annual bases or with a multi-year contract or other funding vehicle. Long-term costs will be funded by a non-wasting endowment or other “in perpetuity” funding mechanism.

3.5.5.5 Land Management by Owner or Third Party

The intent is to allow any qualified entity, including the owner of private property, to implement the management plan for a parcel or tract associated with the RASP. The responsibility for

management belongs to the party with which the USMC has an agreement; however, actual management activities may be conducted by contractors or third parties when required.

3.5.5.6 Management of Red-cockaded Woodpecker Translocation

The term translocation has been broadly applied to RCW conservation programs involving their capture at one location, transport, and release at another location. As described in the RCW Recovery Plan, RCW translocation has been used to reestablish the species in extirpated populations or portions of its range, to develop more stable spatial arrangements of PBGs reducing isolation or fragmentation, to augment and increase size of small populations reducing vulnerabilities to extirpation from stochastic demographic and environmental factors, and to manage genetic resources (e.g., Costa and DeLotelle 2006). All of these objectives are applicable under certain RASP property conditions.

Most RASP properties are unlikely to be initially occupied by RCWs due to unsuitable habitat and the fragmentation of historical RCW populations in the CNCPC-Project Area landscape. While RASP management will restore and increase suitable habitat, the establishment of RCW PBGs at RASP property recruitment clusters is dependent on natural RCW group induction and/or translocation. Natural group induction is a consequence of the natural dispersal of breeding age RCWs from other segments of the population or subpopulation that pair and establish a territory at a RASP recruitment cluster. Group induction at recruitment clusters in restored and managed habitat is the method by which RCW recovery and other managed populations has increased substantially throughout the species range. Natural group induction is expected at RASP properties because they must be spatially located to demographically and genetically function with the CNCPC population; thus, new and additional RASP RCW groups will become established at recruitment clusters by successful natural RCW dispersal from other CNCPC population segments as well as other RASP groups.

The rate for successful RASP group induction will be affected by the size of the property, the number and location of recruitment clusters established over time in response to habitat restoration conditions, and the density and proximity of other RCW groups in the population.

Depending on these conditions, RCW translocation to RASP recruitment clusters in conjunction with group induction may accelerate reintroduction and the establishment of PBGs, augment or increase a RASP property population or subpopulation, as well as establish PBGs in spatially important positions to increase PBG density and reduce isolation among groups.

RCW translocation involving RASP properties, when appropriate, will consist of either mate provisioning or potential RCW pairs. Mate provisioning occurs when a single-bird territory on a RASP property, typically a male, is provided a breeding age, usually subadult (young-of-year) female translocated from another PBG. The translocation of a RCW pair consists of a subadult male and female captured at different groups and released as a pair at a RASP recruitment cluster.

The RCW translocation component of the RCW Management/Monitoring Plan will identify RASP property and general RCW conditions when translocation would be conducted. Each RASP property will be identified within a specified CNCPC subpopulation based on factors including, but not limited to, the location of the property, the proximity of existing or future RASP RCW groups relative to groups on other properties, the suitability of habitat for RCW dispersal and occupancy among managed properties, and RCW spatially explicit individual-based models simulating patterns of RCW movement and establishment of new groups at recruitment clusters. The subpopulation assignment will be based on the demographic and genetic function at maximum RCW PBG capacity on RASP and other properties in the CNCPC. These data in some instances may indicate a RASP property at RCW PBG capacity will demographically link two or more CNCPC subpopulations, in which case they will be combined as a single subpopulation. At this time, there are at least six subpopulations among the designated CNCPC recovery properties: Croatan NF East, Croatan NF North, Croatan NF Southwest, Holly Shelter Game Lands, MCB Camp Lejeune East, and MCB Camp Lejeune West (Walters et al. 2011).

Translocations will be either within a CNCPC subpopulation, between CNCPC subpopulations (e.g., RASP recipient and source are different subpopulations within the CNCPC population), or between populations (e.g., the RCW source is a separate population from the CNCPC). Within-subpopulation translocations typically will be mate provisioning, although provisioning also can occur when a single-bird RASP territory is provided a translocated RCW from another CNCPC subpopulation or separate population. Translocation of subadult RCW pairs from other PBGs in RASP property or subpopulation over the relatively short distances to RASP property recruitment clusters are not expected because these translocated RCWs are more likely to return to their natal territories across the relatively small number of intervening territories or distances between the source and recipient clusters. Except for mate provisioning by translocations within a RASP property or subpopulation, the USFWS (Raleigh Field Office and/or RCW Recovery Coordinator) will annually review and approve any proposed RCW translocation.

All elements of the RCW Recovery Plan Appendix 3 Protocol for translocation will apply. These elements address the confirmation of suitable recipient and recruitment clusters for either subadult pairs or single-birds, the timing of RCW capture and transport, and their release and subsequent monitoring. Likewise, any translocation will comply with the RCW Recovery Plan Translocation Guidelines (Section 8.H) except when modified as described below. All translocated birds will be banded and translocated from September 15 to January 01 only as:

- Subadults (<12 months old) from their natal territory;
- Males when there is at least one male helper or male subadult remaining in the group after removal, with no more than two subadult males removed from any group; and
- Females limited to no more than two removed from any group.

As further provided in the RCW Recovery Plan, any translocation involving a RASP property will meet each of the following requirements, which will be included in RASP property management plan:

- Full administrative support, including valid state and federal permits and staff well-trained in the capture, handling, banding, and transport of birds;
- A management plan approved by the USFWS that includes population monitoring, a prescribed burning program for nesting and foraging habitat, and specific identification of the objectives and locations of the proposed translocations;
- Recipient clusters that are in excellent condition, with a minimum of four suitable cavities per cluster, no or very low midstory within the cluster, suitable foraging habitat, and generally no more than two recruitment clusters for each RCW pair moved; and
- RCWs in the recipient population or subpopulation must be completely color-banded.

The RCW Recovery Plan Translocation Guidelines provide criteria to determine the conditions when a "population" is eligible to receive and donate translocated RCWs. These guidelines do not distinguish special conditions for "subpopulations." The following modifications respond to the unique nature of the CNCPC, which is a subdivided population without strong demographic connectivity among the designated properties or subpopulation segments at MCB Camp Lejeune, Holly Shelter Game Lands, and Croatan NF.

A CNCPC subpopulation can serve as a donor to other CNCPC subpopulations and RASP properties when one of the following criteria is satisfied:

- The subpopulation (e.g., MCB Camp Lejeune, Holly Shelter Game Lands, Croatan NF, or other) has reached the size required for its portion of the CNCPC RCW population size objective, and the population trend is stable or increasing; or
- The subpopulation is within 75 percent of its apportioned CNCPC recovery goal, whether active clusters or PBGs, and increasing at 3 percent annually or more; or
- The subpopulation is at least 30 PBGs in size, with a stable or increasing population trend at 3 percent annually or more.

Donor CNCPC subpopulations must also satisfy each of the following management and monitoring elements:

- Subpopulations with 30 – 249 PBGs will be annually monitored, at a minimum, for 100 percent of all potentially active clusters to determine the number of active clusters and PBGs;
- The subpopulation must have a management plan approved by the USFWS, addressing habitat restoration and maintenance for RCW foraging and clusters at recovery levels; and

- Annual monitoring and maintenance to provide at least four suitable cavities for each cluster.

Any other donor population (e.g., other than the CNCPC) must meet all standard donor criteria as described in Section 8.H of the RCW Recovery Plan. A RASP recipient property and subpopulation must consist of less than 30 PBGs to receive RCWs from another donor population. The first priority for potential donors will be those in the Mid-Atlantic Coastal Plain RCW recovery unit, of which the Francis Marion Primary Core is the only current candidate.

All translocations will be monitored for translocation success during the first subsequent breeding season. Mate provisioning is successful when the translocated RCW remains on the single-bird territory where released as paired mate. The translocation success of RCW pairs from any source will be spatially assessed at two domains, RASP property and the subpopulation in which RASP property belongs. Overall success of translocated RCW pairs to a RASP property will be computed as the proportion of all RCWs translocated during a given year that remained on RASP property. Categories of overall success of translocated RCW pairs will be calculated as the proportion of birds that became a PBG (mate), single-bird on a territory, helper, or floater. A successful PBG does not depend on a translocated pair remaining together at the recruitment cluster where released. Overall translocation success and categories of success also will be computed for RCWs remaining in the subpopulation where released. Translocation success data will be assessed and reported annually in addition to other data including, but not limited to, the source of translocated RCWs, band identities of each translocated RCW, locations of recruitment clusters where released, location of clusters where translocated RCWs became a member of a group, and the identity of the PBG mate as either a resident or another translocated RCW.

New information, analysis, or other data resulting in any future change in the USFWS's classification of the current CNCPC recovery population will be incorporated accordingly in the translocation protocols for RASP properties. For example, any change of one or more current CNCPC subpopulations as a separate recovery population will concurrently change their status from a potential CNCPC subpopulation RCW translocation donor to a population donor, for which all population donor requirements will apply. The criteria for an eligible recovery population donor in the RCW Recovery Plan are:

- The population has reached the size required for delisting, and population trend is stable or increasing;
- The population is within 75 percent of its population goal, at least 50 active clusters in size, and population trend is increasing at 3 percent annually or more; or
- The population is at least 100 active clusters in size and population trend is stable or increasing; or
- The population contains multiple properties and the donor property has attained its property goal.

3.5.6 Legal and Enforceable Federal Remedies

3.5.6.1 Agreements, Contracts, and Real Estate Transactions

Every RASP agreement and contract will include provisions for a dispute resolution process for addressing situations where the property owners and/or responsible parties fail to meet their obligations under the agreement. The dispute resolution process will provide a method for continuation of management of the property for RCW protection in the event that the owners and/or responsible parties fail to meet their obligations for any reason. If necessary, a bond equal to the present value of the management costs may be posted or some other mutually agreed to form of surety may be used to ensure performance. The Agreement will contain provisions for contingencies that a prudent man would plan for; however, not every single possible contingency will necessarily be addressed. The owners and/or responsible parties would not be held responsible for offsetting acts of nature that are unforeseen, or foreseeable but unpredictable, such as hurricanes, floods, or fires.

The agreement will stipulate the general procedures for identifying, implementing, and funding remedial measures in the event of unexpected contingencies (fires, floods, etc.). These remedial measures will be based on both information in the monitoring reports and the Service's on-site inspections. The Service, in consultation with the owner/responsible party, will decide on the need for remediation.

As mentioned in Section 3.5.2, conservation easements, when used, will serve to provide a permanent, enforceable mechanism for preserving the habitat on the property in such condition to facilitate management for RCW. The easement will contain language giving the federal government rights to correct deficiencies in RCW management that result from violations of the terms of the easement, should they occur.

3.5.6.2 Red-cockaded Woodpecker Management/Monitoring Assurances

Agreements and easements will include provisions for monitoring the property in question by the federal government, including the USFWS. Annual RCW population reports, and a report detailing the management activities on the property, will be provided to MCB Camp Lejeune and the USFWS.

3.5.6.3 Review of Non-wasting Endowments

As detailed in Section 3.5.1.2, financial arrangements and transactions associated with Agreements will have terms and conditions that require the project sponsor and/or property owner, as appropriate, to maintain complete and accurate records relating to the financial operation of the project. Agreements will provide for auditing of financial records. Records relating to the financial operation of the project will be audited by an independent, licensed

Certified Public Accountant. Results of audits will be available to all parties of the agreement and the Service.

3.6 UNITED STATES FISH AND WILDLIFE SERVICE FINAL APPROVAL OF PROPERTY PROTECTIONS AND ASSURANCES

Prior to USFWS approval, review of the identified property and its potential benefits to RCW conservation and species recovery will have graduated through the rigorous analyses described above. When MCB Camp Lejeune and USFWS are satisfied that the RASP components expressed in Sections 3.5.1 through 3.5.6, pertaining to funding and executing recovery standard management activities on a subject property into perpetuity, the USFWS will approve the reduction of the MCB Camp Lejeune RCW recovery goal, and inclusion of the property into the RCW recovery conservation landscape for the purposes of future Section 7 consultations.

The USFWS approval of MCB Camp Lejeune's determination that a property would provide biological function as part of the CNCPC population and approval of reduction of the MCB Camp Lejeune RCW recovery goal are separate actions from the review of a project on the installation that would result in incidental take of RCWs. In accordance with Section 7 of the ESA, the status of the CNCPC population, including each of its subpopulations will constitute the environmental baseline for consultations involving future projects that include impacts to existing or future PBGs and associated habitat within the CNCPC population. Recently developed computer population modeling techniques including the DSS and LEA/POM are tools available for helping to evaluate the affects of a project on factors such as RCW abundance and persistence, genetic drift, and inbreeding. These tools will be utilized as necessary to ensure that "best available science" is used to inform decisions regarding potential impacts to RCW. The expanded conservation landscape has considerable potential to benefit MCB Camp Lejeune's military mission, since application of the RASP has the capability of promoting the growth of subpopulations comprising the CNCPC population, potentially reducing the ecological significance of existing groups and recruitment clusters on the installation. The future degree of success in managing the property and current state of its potential to reach management goals will become part of the Section 7 environmental baseline for any future projects, including cases where RCW population goals might be exceeded.

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4.0 PROGRAMMATIC BIOLOGICAL ASSESSMENT JOINT COORDINATION AND PERIODIC EVALUATION

MCB Camp Lejeune, USFWS, and RASP property managers/agreement participants will meet at least once annually to discuss monitoring results, challenges to habitat management, prescribed fire, and other issues pertaining to agreement participants. These meetings would facilitate partner communication, cooperation, planning, and annual report review. Periodic review may result in changes to the management actions in order to improve effectiveness.

In addition to providing annual reports to the USFWS pursuant to Section 3.7.5 above, MCB Camp Lejeune will conduct a programmatic review of data, annual reports, and other information every 5 years, or after major events that MCB Camp Lejeune and the USFWS determines to be a major modification of habitat quantity or quality (e.g., hurricanes, catastrophic wildfires), or if necessitated by a significant change in protected species status (e.g., listing or delisting), in order to evaluate the effectiveness of conservation actions in making progress toward the accomplishment of stated objectives. This 5-year programmatic review may involve re-initiation of consultation so that information regarding the status of the species and the effects of this and other actions can be comprehensively updated and evaluated. Existing agreements between the USFWS and MCB Camp Lejeune regarding reductions in the MCB Camp Lejeune RCW recovery goal will not be subject to change as a result of these periodic evaluations, but will be subject only to the terms and provisions of the agreement that approved the recovery goal reduction.

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APPENDIX A

SPECIES OF CONCERN

IN ONSLOW AND PENDER COUNTIES, NORTH CAROLINA

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Common Name	Latin Name
Animals	
Vertebrate	
Bachman's sparrow	*Peucaea aestivalis*
Black rail	*Laterallus jamaicensis*
Carolina gopher frog	*Lithobates capito*
Eastern Henslow's sparrow	*Ammodramus henslowii susurrans*
Eastern painted bunting	*Passerina ciris ciris*
Mimic glass lizard	*Ophisaurus mimicus*
Rafinesque's big-eared bat	*Corynorhinus rafinesquii*
Southeastern myotis	*Myotis austroriparius*
Southern hognose snake	*Heterodon simus*
Invertebrate	
Buchholz's dart moth	*Agrotis buchholzi*
Carter's noctuid moth	*Spartiniphaga carterae*
Venus flytrap cutworm	*Hemipachnobia subporphyrea*
Plants	
Aquatic	
Grassleaf arrowhead	*Sagittaria weatherbiana*
Loose watermilfoil	*Myriophyllum laxum*
Thin-wall quillwort	*Isoetes microvela*
Ferns	
Carolina spleenwort	*Asplenium heteroresiliens*
Graminoids	
Coastal beaksedge	*Rhynchospora pleiantha*
Hirst’s panicgrass (candidate)	*Dichanthelium hirstii*
Smooth-seeded hairy nutrush	*Scleria* sp. 1
Swamp forest beakrush	*Rhynchospora decurrens*
Thorn’s beakrush	*Rhynchospora thornei*
Herbs	
Awned meadowbeauty	*Rhexia aristosa*
Boykin’s lobelia	*Lobelia boykinii*
Carolina bishopweed	*Ptilimnium ahlesii*
Carolina bogmint	*Macbridea caroliniana*
Carolina grass-of-parnassus	*Parnassia caroliniana*

Common Name	Latin Name
Plants	
Herbs	
Carolina trillium	*Trillium pusillum* var. *pusillum*
Coastal goldenrod	*Solidago villosicarpa*
Many-flowered grass-pink	*Calopogon multiflorus*
Pickering's dawnflower	*Stylisma pickeringii* var. *pickeringii*
Pineland plantain	*Plantago sparsiflora*
Sandhills milk-vetch	*Astragalus michauxii*
Savanna onion	*Allium* sp. 1
Small-leaved meadow-rue	*Thalictrum macrostylum*
Spring-flowering goldenrod	*Solidago verna*
Venus' fly-trap	*Dionaea muscipula*
Shrub	
Georgia lead-plant	*Amorpha georgiana* var. *georgiana*
Pondspice	*Litsea aestivalis*

Data from USFWS 2011b

Table excludes aquatic, marine, and beach/dune fauna.

APPENDIX B
RESULTS OF BIOLOGICAL FUNCTION MODELING WHEN ALL OFF-BASE PROPERTIES ARE RESTORED (BRUGGEMAN ET AL. 2010)

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APPENDIX B-1

TEMPORAL TRAJECTORIES FOR
POTENTIAL BREEDING GROUPS

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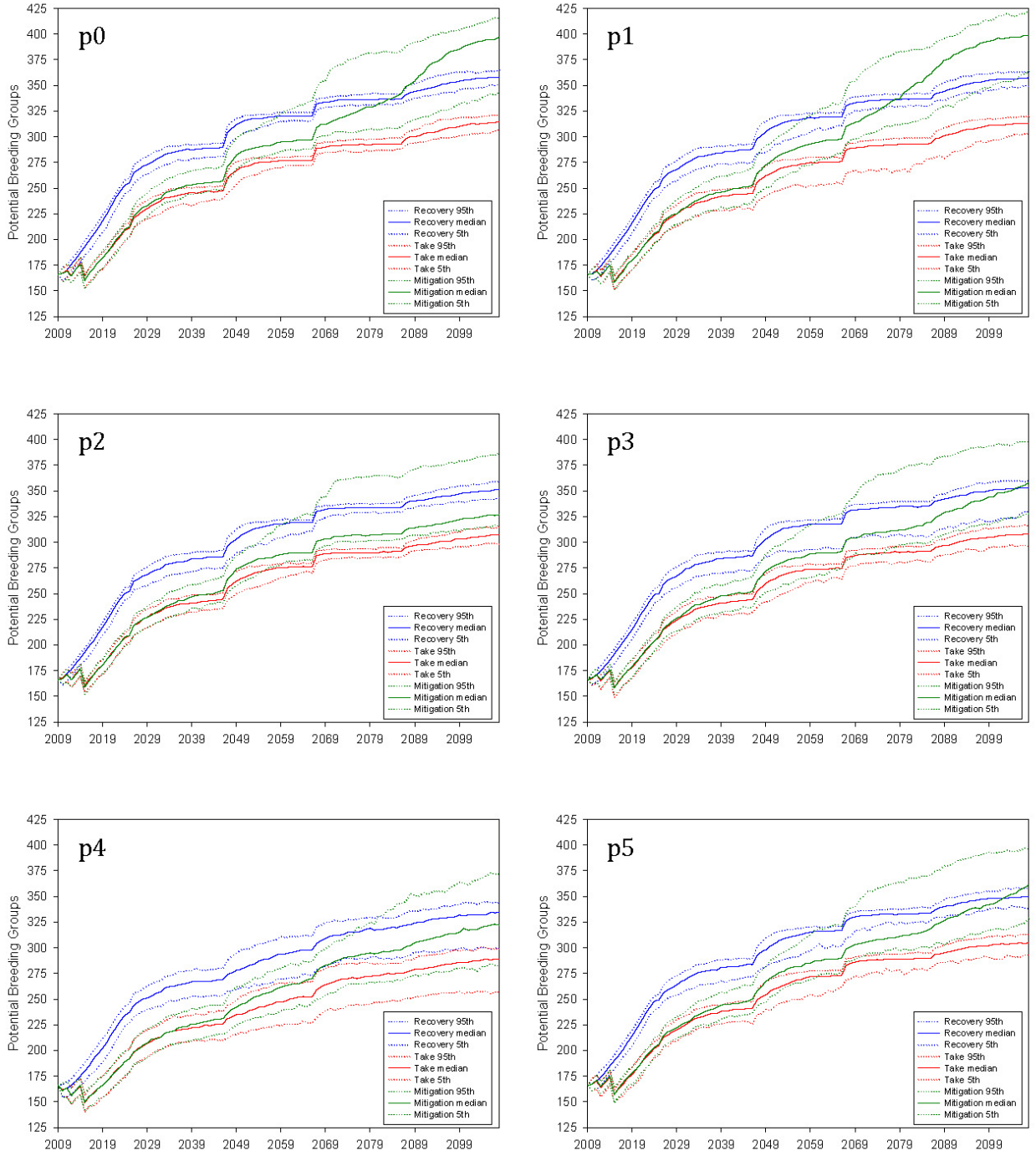

Figure taken from Bruggeman et al. 2010

"Potential Breeding Groups expected under the Recovery, Take, and Mitigation landscapes in the Onslow Bight for each of the six parameterizations (P0 to P5). Mitigation landscape assumes all off-base properties will be restored." (Bruggeman et al. 2010

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APPENDIX B-2

AVERAGE EXPECTED HETEROZYGOSITY
WITHIN BREEDING GROUPS (H_S)

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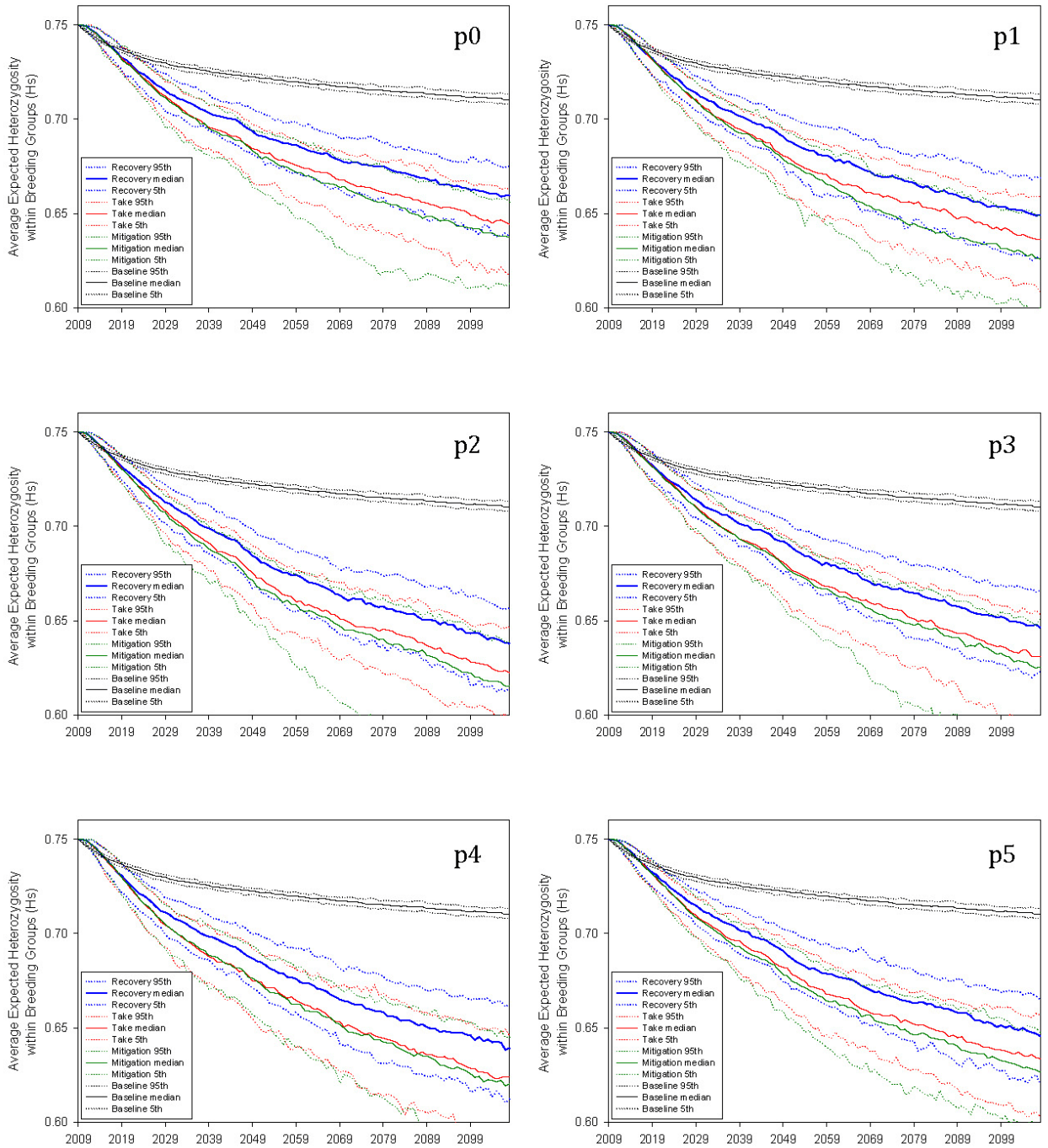

Figure taken from Bruggeman et al. 2010

"Average expected heterozygosity within breeding groups (H_s) expected under the Recovery, Take, Mitigation, and Baseline landscapes in the Onslow Bight for each of the six parameterizations (p0 to p5). Mitigation landscape assumes all off-base properties will be restored." (Bruggeman et al. 2010)

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APPENDIX B-3

AVERAGE GENETIC DIVERGENCE
AMONG BREEDING GROUPS (D_{ST})

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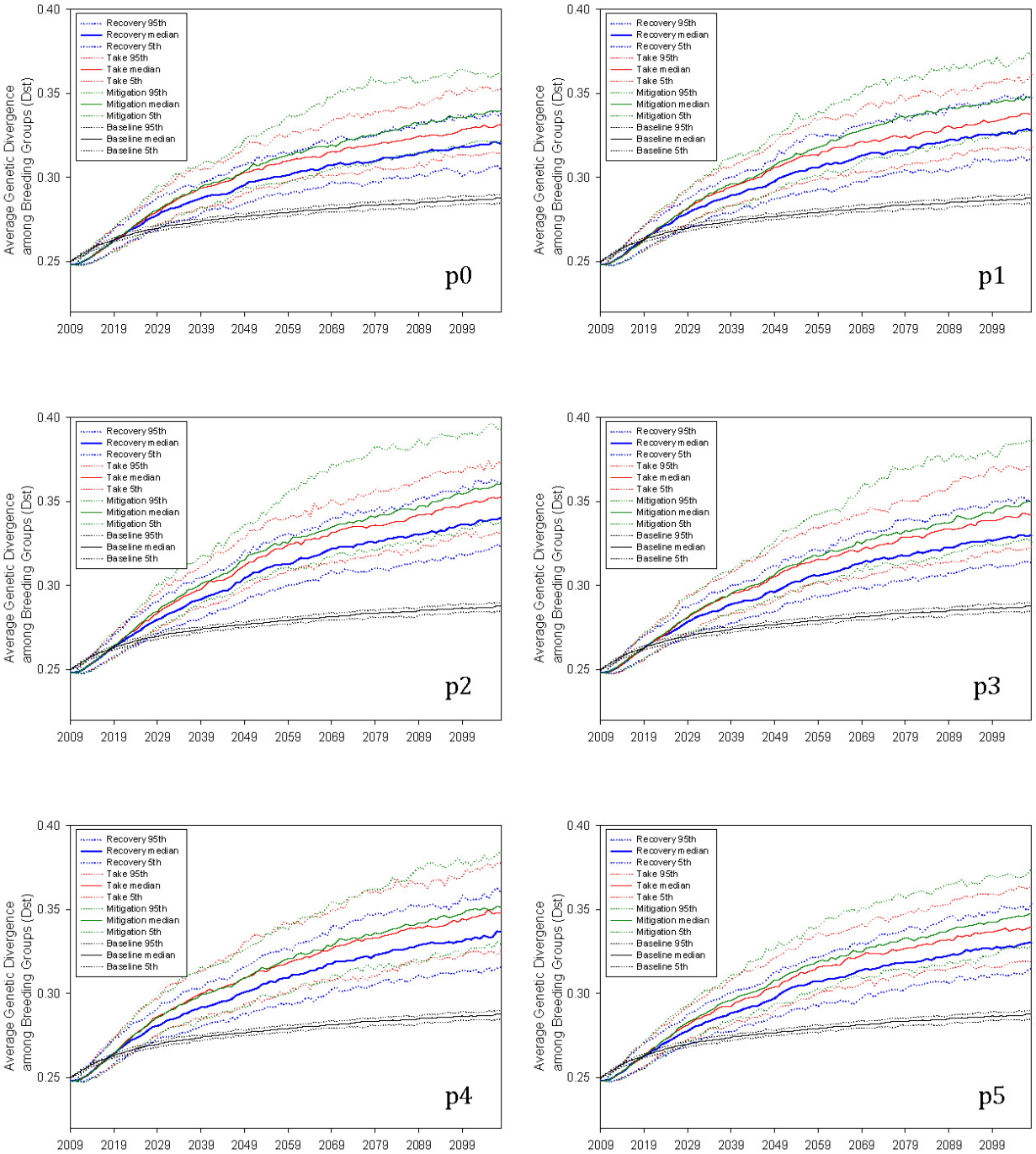

Figure taken from Bruggeman et al. 2010

"Average genetic divergence among breeding groups (D_{st}) expected under the Recovery, Take, Mitigation, and Baseline landscapes in the Onslow Bight for each of the six parameterizations (p0 to p5). Mitigation landscape assumes all off-base properties will be restored." (Bruggeman et al. 2010)

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APPENDIX B-4

WRIGHT'S INBREEDING COEFFICIENT (F)

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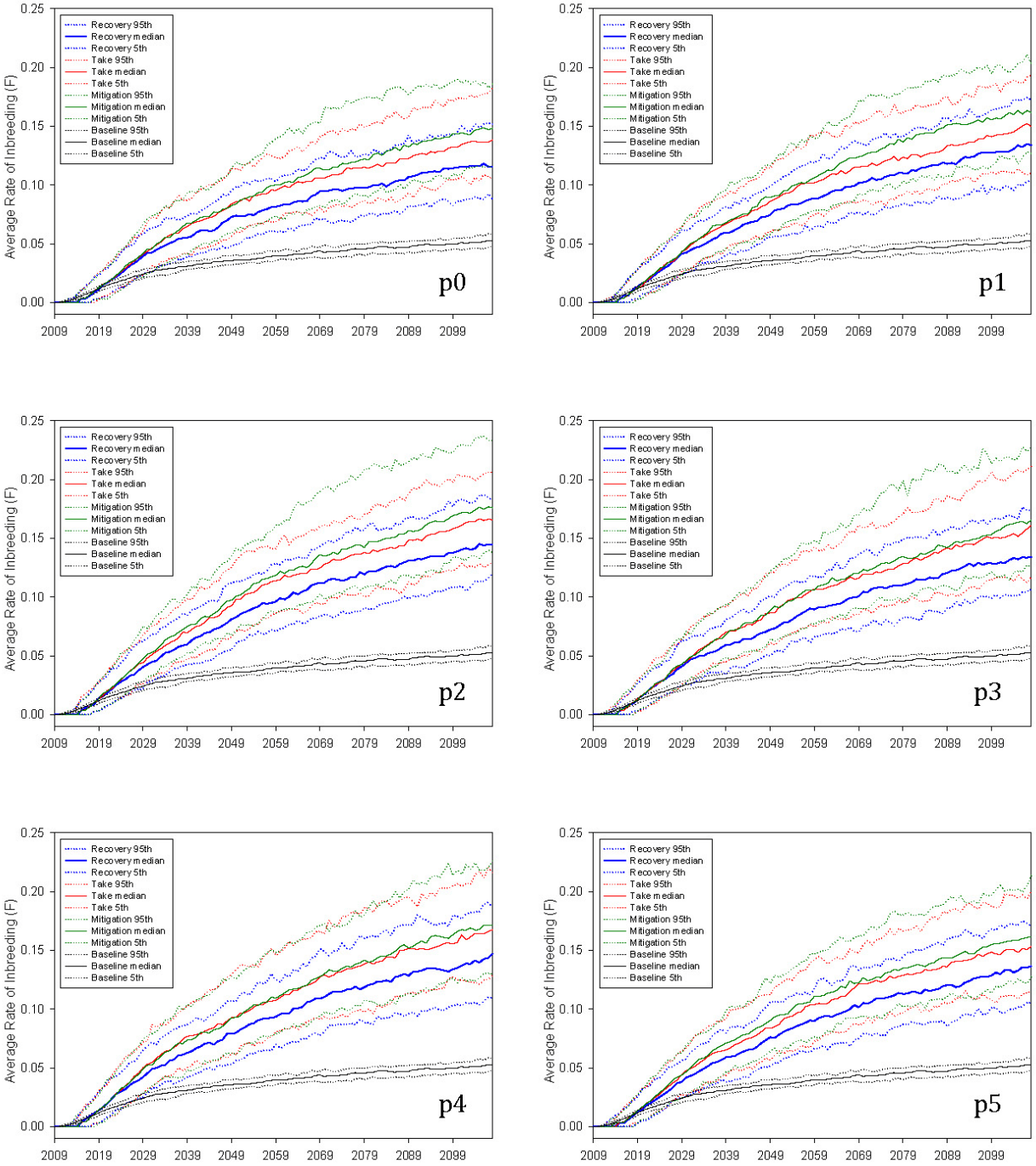

Figure taken from Bruggeman et al. 2010

"Average rate of inbreeding (F) expected under the Recovery, Take, Mitigation, and Baseline landscapes in the Onslow Bight for each of the six parameterizations (p0 to p5). Mitigation landscape assumes all off-base properties will be restored." (Bruggeman et al. 2010)

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APPENDIX C

CONSERVATION BANKING AGREEMENTS

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Information in a Typical Conservation Banking Agreement

1. A general location map and legal description of the property, including GPS coordinates if possible.
2. Accurate map(s) of the bank property on a minimum scale of 7 minutes. U.S. Geological Survey quad map or finer scale, if available.
3. Name of the property.
4. Name of the person(s)/organization(s) to hold fee title to the conservation bank. .
5. Name of the person(s)/organization(s) who will have management responsibility and for how long. This entity must have demonstrated experience in natural resources management.
6. Name of the person or entity who will hold a conservation easement on the property.
7. Preliminary title report indicating any easements or encumbrances on the property.
8. An enumeration of the types of potential activities that may include public access and that are compatible with the property's primary function as habitat for species.
9. A description of the biological value of the property, including habitats, and number of RCW groups that can be supported by the property. This will normally be the information generated to complete the Biological Function Analysis, plus any additional information available.
10. Compliance with applicable state and federal laws such as state-endangered species acts.
11. Results of a Phase I hazardous materials survey for the property.
12. A review of mineral rights associated with the property.
13. Discussion of any prescriptive rights on the property (e.g., road access, etc.),
14. An agreement to accurately delineate in the field all boundaries of the bank property, including any bank phases, and construct any required fences before the first conservation credit is sold, fee title transferred, or conservation easement granted.
15. Provisions for the Service to enter the property for inspections, quality control/assurances and other duties as needed.
16. Contingency management, funding, and ownership plans in the event that the bank owner and/or manager fails to fulfill the obligations as listed under the bank agreement and management plans, including an applicable dispute resolution process to address these contingencies.
17. A management plan for the bank property, including performance standards that must be achieved

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APPENDIX D

EXAMPLE CONSERVATION EASEMENT

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(EXAMPLE)

GRANT OF CONSERVATION EASEMENT

THIS EASEMENT, made this _____day of _____, 20___ by and between _____, a body politic and corporate, hereinafter called GRANTOR, and the UNITED STATES OF AMERICA, acting by and through the Department of the Navy, hereinafter called GOVERNMENT;

The designation of GRANTOR as used herein shall include its successors and assigns, and shall include singular, plural, masculine, feminine or neuter pronouns as required by context.

W I T N E S S E T H:

WHEREAS, the GRANTOR is the sole owner in fee simple of certain property ("Property"), hereinafter described tract of land containing _____ acres, more or less, located in _____ County, State of North Carolina and situated near the Marine Corps Base, Camp Lejeune, North Carolina (the "Installation"); and

WHEREAS, it is in the public interest to limit any development or use of the property that would be incompatible with the mission of the Installation and preserve habitat on such property in a manner that is compatible with environmental requirements and may eliminate or relieve current or anticipated environmental restrictions that would or might otherwise restrict, impede, or otherwise interfere, whether directly or indirectly, with current or anticipated military training, testing or operations on such Installation; and

WHEREAS, it is in the public interest to conserve, enhance, restore, and maintain the natural features and resources of such property, to provide habitat for native plants and animals, to improve and maintain water quality, and to control runoff of sediment (hereinafter the "Conservation Values"); and

WHEREAS, the GRANTOR and the GOVERNMENT entered into an agreement identified as Encroachment Protection Agreement Number N40085-09-RP-00013, dated 30 July 2009, whereby the GRANTOR and the GOVERNMENT agreed to coordinate for the acquisition of certain real property interests

in the vicinity of Marine Corps Base Camp Lejeune, Marine Corps Air Station New River, and Marine Corps Air Station Cherry Point, North Carolina; and

WHEREAS, it is the purpose of this Easement to prevent any improvement, development or use of the Property that would be incompatible with the Conservation Values of the Property or which would or might otherwise restrict, impede or otherwise interfere, whether directly or indirectly with current or anticipated military training, testing or operations on or in the vicinity of Installation; and

WHEREAS, the property subject to this Easement is _____acres, more or less, and is more particularly shown and described on the survey entitled "_____" prepared by "_____", dated "_____" and recorded in Plat Cabinet/Drawer _____, slide(s) _____, _____ County Registry; hereinafter the "Survey"; and

NOW THEREFORE, pursuant to Section 2684a of Title 10 of the United States Code; for and in consideration of the sum of _____ paid to GRANTOR, receipt of which is hereby acknowledged, the GRANTOR does hereby grant and convey to the GOVERNMENT, a perpetual Easement appurtenant to restrict the use and development of said Property that would be incompatible with the Conservation Values defined herein and which may eliminate or relieve current or anticipated environmental restrictions that would or might otherwise restrict, impede, or otherwise interfere, whether directly or indirectly, with current or anticipated military training, testing, or operations on or in the vicinity of the Installation or be incompatible with the mission of the Installation, and to provide for ingress and egress on, over and across said Property more particularly described as:

(Legal Description)

BEING the same property acquired by the GRANTOR by deed recorded in the Register of Deeds Office, Pender County, North Carolina in Deed Book_____, Pages _____-_____.

The perpetual Easement and rights for restrictions, ingress and egress are described as follows:

ARTICLE I. RIGHTS RESERVED TO GRANTOR.

GRANTOR reserves certain rights accruing from the fee simple ownership of the Property, including the right to engage in or permit others to engage in the uses of the Property that are not inconsistent with the purpose(s) of this Conservation Easement. All rights reserved by the GRANTOR, are reserved for GRANTORS, their representatives, successors, and assigns, and are considered to be consistent with the conservation purposes of this Conservation Easement. Except for the specific restrictions and prohibitions made applicable herein to the Property, GRANTOR shall continue to own and may use the Property in any lawful manner that is not inconsistent with the purposes(s) of this Easement. GRANTOR expressly reserves the following rights:

A. Natural Resources Management. GRANTOR reserves the right to engage and to permit others to engage in uses of the Property associated with natural resources management activities, requiring no surface alteration of the land, so long as the related alterations, construction, improvements, maintenance and activities and uses therein, pose no threat to the Conservation Values of the Property. Approved natural resources management activities shall include, but not be limited to, managing existing wildlife openings, establishing firebreaks and logging decks, maintaining existing roads and trails, marking boundaries, installation and maintenance of signs, biological survey activities and research activities. Timber harvest and reforestation activities are restricted to those consistent with management, maintenance and improvement of forested areas and potential forested areas for the benefit of red-cockaded woodpecker populations in accordance with the U.S. Fish and Wildlife Service's Red-Cockaded Woodpecker (*Picoides borealis*) Recovery Plan (Second Revision, 2003), and any revision thereto which may be made at a later date, as it applies to State agencies.

B. Public Use and Access. GRANTOR reserves the right to allow public access and use of the Property for the purpose of recreational activities, including, without limitation, conducting educational tours, scientific study, animal/plant observation, walking, hunting, trapping, fishing, and any other purposes consistent with these accepted uses and maintaining Conservation Values.

C. Canoe/Kayak Access Site. GRANTOR reserves the right to construct, maintain and repair canoe/kayak access site(s) on the Property as allowed by applicable state and federal wetland, erosion and sedimentation regulations and state and municipal construction codes. All necessary care shall be taken to complete the construction of such features in a manner so as not to cause or allow sedimentation either during or after construction.

Notwithstanding the foregoing, all amenities and improvements to be located on the Property must receive the prior written approval of the GOVERNMENT, and must comply with the terms set forth herein. Approval by the GOVERNMENT shall not be unreasonably withheld. The GRANTOR shall maintain the Property for the benefit of wildlife and shall comply with all applicable land use regulations, and other applicable laws and ordinances. The total cleared, and not re-vegetated, pervious and impervious surface areas shall not exceed ten percent (10%) of the total area of the Property.

ARTICLE II. PROHIBITED & RESTRICTED ACTIVITIES.

Any activity on, or use of, the Property inconsistent with the purposes of this Conservation Easement is prohibited. The Property shall be managed using sound forestry, soil, water and wildlife management techniques and shall be restricted from any development or use that would impair or interfere with the water quality protection and conservation purposes of this Conservation Easement, set out above.

Except for those rights specifically reserved to GRANTOR and without limiting the generality of the foregoing, the following is a listing of activities and uses which are prohibited, or where expressly stated, which may be permitted, on the Property. GRANTOR and GOVERNMENT have agreed that the activities specifically allowed do not and will not impair the Conservation Values of the Property.

A. Industrial and Commercial Use. All industrial and commercial activities and uses, and any right of passage for such purposes, are prohibited on the Property.

B. Disturbance of Natural Features. The disturbance of natural resources is prohibited except as necessary for (i) removal of hazards to visitors, (ii) control of disease that would damage or reduce the significance of the preserve, (iii) restoration after severe storm damage, (iv) trail clearance and maintenance, (v) daylighting of roads, (vi) maintenance or restoration of natural communities or rare species populations, (vii) purposes incidental to boundary marking, fencing and signage allowed or required hereunder; (viii) those forest management activities that promote wildlife habitat and sound forestry management. Fishing is authorized pursuant to applicable federal, state and local rules and regulations. Control of wildlife populations using accepted management techniques is authorized to include hunting and trapping, to provide public opportunity and to keep animal populations within numbers consistent with the ecological balance of the area and as pursuant to federal, state and local rules and regulations.

C. Construction of Buildings and Recreational Use. There shall be no construction or placement of any building, mobile home, asphalt or concrete pavement, billboard or other advertising display, antenna, utility pole, tower, conduit, line, pier, landing, dock or other temporary or permanent structure or facility on, above, or below the surface of the Property, except for the following: placing and display of no trespassing signs, local, state or federal traffic or similar informational signs, for sale or lease signs, fencing, signs identifying the Conservation Values of the Property, and/or signs identifying the source of funds for the conservation easements on the Property, educational and interpretive signs, identification labels or any other similar temporary or permanent signs.

D. Mineral Use, Excavation, Dredging. There shall be no filling, excavation, dredging, mining or drilling; no removal of topsoil, sand, gravel, rock, peat, minerals or other materials; and no change in the topography of the Property in any manner, except as may be necessary for the purpose of combating erosion, maintaining roads, trails and ditches or incidental to any conservation management practices otherwise permitted by this Conservation Easement.

E. Wetlands and Water Quality. No activities causing or contributing to pollution of or alteration of water bodies will be conducted, permitted, and every attempt will be made to terminate any unauthorized activities on the Property; furthermore, no activities will be conducted, permitted, or allowed to continue, to the detriment of water purity or that alter natural water levels or drainage, or that contribute to sedimentation, or that alter surface water flow, in or over the Property or into any surface waters adjacent thereto, or that may otherwise cause soil degradation or erosion; nor shall any diking, dredging, draining, piping, filling, or other activity causing any alteration to wetlands be conducted, permitted, or allowed to continue on the Property, except activities to restore natural hydrology, or wetlands enhancement, as permitted by state and other appropriate authorities, and only then after and with the prior consent of the GOVERNMENT.

F. Dumping. Dumping of soil, trash, ashes, garbage, or waste, abandonment of vehicles, appliances, or machinery, or other waste or discarded materials, is prohibited on the Property.

ARTICLE III. RIGHTS OF THE GOVERNMENT.

A. Ingress and Egress. The GOVERNMENT shall have a perpetual easement for ingress and egress, at reasonable times and places, for the purpose of exercising and enforcing the rights set forth hereinabove; reserving, however, to the GRANTOR, any and all rights and privileges as may be used and enjoyed without interfering with or abridging the rights hereinabove set forth.

B. Conservation. The GRANTOR shall manage the Property in a manner necessary to conserve and recover the Red-Cockaded Woodpecker consistent with the U.S. Fish and Wildlife Service's Red-Cockaded Woodpecker (*Picoides borealis*) Recovery Plan (Second Revision, 2003), and any revision thereto which may be made at a later date, as it applies to State agencies. As part of the consideration for GOVERNMENT's contribution to this Easement, GRANTOR agrees not to sell, transfer, or encumber any current or future RCW clusters or groups, or their habitat, for use as mitigation, credits or other similar purposes, to any entity except the GOVERNMENT without express written permission from the GOVERNMENT. .

C. Enforcement. The GOVERNMENT shall have the right to prevent and correct violations of the terms of this Easement through administrative and/or legal procedures. Upon advance coordination with GRANTOR, the GOVERNMENT may enter the Property for the purpose of inspection for violations of the terms or provisions of this Easement. If the GOVERNMENT discovers a violation, it may, at its discretion, take appropriate enforcement action, to include instituting legal action. Provided, however, the GOVERNMENT shall give the GRANTOR, or any successors or assigns, written notice of the violation and sixty (60) days to correct any such violation (or begin good faith efforts to correct in the event the violation is something which cannot be reasonably corrected in sixty (60) days) before filing any legal action. If a court of competent jurisdiction determines that a violation exists or has occurred, the court may enjoin any inconsistent use and may require the GRANTOR, its successors or assigns, to correct the violation or restore the Property to the condition prior to the violation. Failure of the GOVERNMENT to discover a violation or to take immediate legal action shall not bar it from doing so at a later time.

ARTICLE IV. RESPONSIBILITIES.

A. Transfer of Property. Any time the GRANTOR transfers any or all interest in the Property to any third party, the GRANTOR shall notify the GOVERNMENT in writing at least thirty (30) days prior to the transfer of the Property, and the document of conveyance shall expressly state that the rights, entitlements, use and enjoyment of the Property being conveyed are subject to the restrictions and provisions set forth in this Easement.

B. Notice. Any notice, transmittal, approval, or other official communication made under this Easement shall be in writing and shall be delivered by hand, facsimile transmission, certified electronic mail, or by U.S. postal mail to the respective owners of record for interests in property at the address or facsimile transmission telephone number set forth below or at such other address as may be later designated, and such notice shall be effective upon date of receipt.

For GRANTOR:

For GOVERNMENT:
Commanding Officer, NAVFAC MIDLANT

Attn: Real Estate Director
9742 Maryland Avenue
Norfolk, VA 23511-3095

C. Responsibilities of GRANTOR and GOVERNMENT not affected. Other than specified herein, this Easement is not intended to impose any legal or other responsibility on the GOVERNMENT, or in any way affect any existing obligation or responsibility of the GRANTOR as owner of the Property.

The GRANTOR covenants with the GOVERNMENT that it is seized of said Property in fee simple; that GRANTOR has the right to convey, and voluntarily conveys for the agreed upon price, this Easement with the additional authority for the GOVERNMENT to control and restrict the use and development of GRANTOR's Property as provided in this Easement; that title is marketable and free and clear of all encumbrances; and that the GRANTOR will warrant and defend the title against the lawful claims of all persons whomsoever, except for Easement of record; and that GRANTOR will execute such further assurances as may be required.

IN WITNESS WHEREOF, the GRANTOR has caused this GRANT OF EASEMENT to be executed as of the day and year first above written.

(NAME)

_____
(Title)

STATE OF NORTH CAROLINA

COUNTY OF _____

I, _____ a Notary Public for _____ County, North Carolina, do certify that _____, Secretary of State of the State of North Carolina, personally came before me this day and acknowledged that she is Secretary of State of the State of North Carolina, and that by authority duly given and as the act of the State, the foregoing instrument was signed in its name by_____, Governor of the State of North Carolina, sealed with the Great Seal of the State of North Carolina, and attested by herself as Secretary of State.

IN WITNESS WHEREOF, I have hereunto set my hand and Notarial Seal, this the _____day of _____, 20_____.

_____
Notary Public

My commission expires: _____

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APPENDIX E

EXAMPLE

EXHIBIT A: STATE PROPERTY DEDICATION

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SECTION .0300 - DEDICATION OF NATURE PRESERVES

15A NCAC 12H .0301 OBJECTIVES OF DEDICATION

(a) The State may accept the dedication of nature preserves on lands deemed by the Secretary to qualify as outstanding natural areas, based on the criteria of eligibility as stated in Rule .0202 of this Subchapter. The owner of a qualified natural area may dedicate a nature preserve by transferring fee simple title or other interest, estate, or right in his land, or portion thereof, to the State. Dedicated nature preserves may be acquired by gift, grant, or purchase. The Secretary may recommend to the Governor and Council of State, through the Director of the Office of State Property in the Department of Administration, that an area be dedicated as a nature preserve. Dedication of a preserve becomes effective only upon acceptance of articles of dedication by the Governor and Council of State. Articles of dedication shall be recorded in the county(ies) in which the nature preserve is located, in the Office of State Property, and in the office of the Natural Heritage Program.

(b) Preserves, created by dedication, are declared to be at their highest and best use for public benefit, by serving one or more of the following public purposes:

(1) Contribute to the growth and development of public understanding of and empathy for natural systems, and the consequent development of public understanding for the interdependence of all forms of life and vital dependence of the health of the human community on the health of other natural communities.

(2) Provide sites for scientific research and examples for scientific comparison with more disturbed sites.

(3) Provide sites for educational activities and places where people may observe natural biotic resources and environmental systems.

(4) Provide habitat for the survival of rare plants or animals or natural communities or other significant biological features.

(5) Provide opportunities for contemplation or outdoor recreation compatible with the protection of the natural area.

(6) Provide places for the preservation of natural beauty.

History Note: Authority G.S. 113A-164.4; 113A-164.6; Eff. August 30, 1980; Amended Eff. January 1, 1986; October 1, 1984.

15A NCAC 12H .0302 DEDICATION PROCESS

(a) Each area proposed for dedication as a nature preserve shall be examined and reported on in writing to the Secretary by the Natural Heritage Program or other person or persons designated by the Secretary.

(b) The report on the proposed area shall include information on its location, legal description, ownership, provision for custody and management, general character, natural types, environmental significance, degree of past disturbance, relation to adjoining lands, potential as a nature preserve, and interest of the owner in dedication.

(c) Upon receipt of the report and recommendation from the Natural Heritage Program and recommendation from the Natural Heritage Advisory Committee, the Secretary shall make a determination that the proposed area qualifies under criteria set forth under Rule .0202 of this Subchapter and constitutes a natural area worthy of protection through dedication as a nature preserve, and if the owner is willing to have the land or a portion thereof dedicated as a nature preserve, through the Office of State Property to the Governor and Council of State.

(d) A natural area shall become a nature preserve upon acceptance of articles of dedication by the Governor and Council of State. Preserves are created when natural areas are dedicated by:

(1) a person or other owner who may transfer to the State the title or other interest in the land with articles of dedication agreed to by the owner and the State. The articles of dedication shall include a statement of the public purposes served by the dedication and declare that the State shall hold such title or interests in trust for the public as a dedicated preserve under terms and authority of the Nature Preserves Act, G.S. 113A-164.7.

(2) Any local unit of government who may transfer fee simple title or other interest in land to the State through articles of dedication agreed to by the local government agency and the State. The articles of dedication shall include a statement of the public purposes served by the dedication and name the State as trustee for the dedication.

(3) the State itself for State owned lands through articles of dedication and declare the State as trustee for the dedication, subject to allocation pursuant to the provisions of G.S. 143-341(4)g. The Secretary and Director of the Office of State Property shall make recommendations to the Governor and Council of State for dedicating State owned lands as nature preserves.

History Note: Authority G.S. 113A-164.4; 113A-164.6 through 164.10; Eff. August 30, 1980; Amended Eff. August 1, 1988; January 1, 1986.

15A NCAC 12H .0303 ARTICLES OF DEDICATION

(a) Articles of dedication shall be developed and accepted as follows:

(1) Articles of dedication must consist of such rights and restrictions as: (A) will adequately protect the qualifying natural features of the land under Rule .0202 of this Subchapter, and (B) will provide and protect the public purposes described in the articles of dedication and complying with Rule .0301(b) of this Section.

(2) Articles of dedication shall contain provisions relating to the management, use, development, transfer, and public access, and may contain any other restrictions and provisions as may be necessary or advisable to protect the public purposes described in the articles.

(3) Articles of dedication shall specify the primary custodian who will be responsible for managing the nature preserve in accordance with the articles of dedication and these regulations.

(4) Articles of dedication may define, consistently with the public purposes of the dedication, the respective rights and duties of the owner and of the State and provide procedures to be followed in case of violations of the restrictions.

(5) Articles of dedication may recognize and create reversionary rights, transfers upon conditions or with limitations, and gifts over, as provided by G.S. 113A-164.6(b)(3) and (c).

(6) Articles of dedication are filed by the State with the county register(s) of deeds in the county(ies) where the land lies and shall become and remain part of the deed until and unless extinguished by the State under provisions in G.S. 113A-164.6(c).

(7) Articles of dedication may be acquired by purchase, gift, or grant, or may be established by the State on lands or interests in lands that it holds, however acquired.

(8) Articles of dedication may not be accepted and recorded without express approval of the Governor and Council of State.

(9) Articles of dedication shall include the right of the State or its agents to enter the land at reasonable times to inspect its condition and to enforce the articles of dedication as needed. This right of inspection does not in and of itself constitute public access.

(10) Articles of dedication may, but need not, provide public access. Such access is preferred where it will not interfere with the qualities of the natural area or subvert the value of the public purposes served by dedication.

(11) Articles of dedication may vary in provisions from one nature preserve to another in accordance with differences in the characteristics and conditions of the area involved, or for other reasons found necessary by the State and the landowner, grantor, devisor, or donor.

(b) Articles of dedication on land remaining in private ownership shall contain provisions for notifying the State before sale or transfer by deed or lease of the land or other interests therein. The State will not regulate or prohibit such sale or transfer but shall insure that the grantee or lessee is familiar with the articles of dedication and understands their meaning and that they are binding on him. The county register(s) of deeds should notify the State whenever dedicated lands are transferred by will or as part of an estate. Local government agencies holding dedicated lands shall notify the State at least 30 days before sale or transfer of the lands or interests therein, and such sale or transfer shall not subvert the purposes of G.S. 113A-164. Sale or transfer of dedicated preserves in State ownership shall not subvert the purposes of G.S. 113A-164.7.

History Note: Authority G.S. 113A-164.6 through 113A-164.10; Eff. January 1, 1986; Amended Eff. August 1, 1988.

15A NCAC 12H .0304 BUFFER AREAS

(a) For the purpose of protecting a nature preserve, adjoining land that is not otherwise suitable for dedication as a preserve may be dedicated as a buffer area in the same manner as a nature preserve.

(b) The articles of dedication may contain provisions for the management, use, development, and public access of the buffer area that differ from those for the adjacent nature preserve.

History Note: Authority G.S. 113A-164.4; 113A-164.6; Eff. January 1, 1986.

15A NCAC 12H .0305 PUBLIC TRUST

The State holds dedicated lands in trust on behalf of the people of North Carolina.

(1) The State shall have authority to promulgate such rules, regulations, and policies as are necessary to insure its ability to protect the public purposes served by dedicated preserves.

(2) Members of the public may bring notice to the Secretary or his agents of suspected violations of terms of dedications. The Natural Heritage Program will respond promptly to investigate notices of violations and shall maintain ongoing monitoring of all dedicated preserves. Subsequent to investigation of a notice of violation, the Natural Heritage Program shall respond to the notifying party and recommend appropriate action to the Secretary. The Attorney General may, on his initiative or at the request of the Secretary, Governor, or Council of State, initiate actions in equity which may include requests for punitive damages and/or for injunctive relief against violators of the articles of dedication on any land so dedicated.

(3) The Natural Heritage Program shall maintain administrative records for dedicated areas. These shall be available for public review at reasonable times, and copies will be available at cost.

(4) The State may enter contracts and agreements with other agencies and persons to manage and/or monitor dedicated preserves, but the State may not abdicate its trusteeship for dedicated lands through such contracts or agreements.

History Note: Authority G.S. 113A-164.4; 113A-164.7; Eff. January 1, 1986.

15A NCAC 12H .0306 AMENDMENTS

(a) Articles of dedication may be amended by the State, subject to the approval of the Governor and Council of State and with the written concurrence of the owner (if not the State), upon finding that such amendment will not permit an impairment, disturbance, use, or development of the area inconsistent with the purposes of G.S. 113A-164.7. Amendments may be approved only after a public hearing in the county(ies) where the dedicated preserve lies. The State shall provide not less than 30 days notice of such hearing in the newspaper(s) where the land lies. The State shall provide not less than 30 days notice to the chief county and/or municipal administrative officials in the jurisdiction(s) where the land lies.

(b) Where purposes of G.S. 113A-164.7 or the purposes of the original dedication will be violated by a proposed amendment, the Governor and Council of State must find that the amendment serves a clear and unavoidable public necessity and no prudent alternative exists, and then only after a public hearing with notice provided in Rule .0306(a) of this Section and then only with the concurrence of the Governor and Council of State.

(c) After the public hearing and finding by the Governor and Council of State, the State shall publish a statement of its findings in the newspaper(s) of largest circulation in the county(ies) where the land lies at least 30 days before the amendment is final.

History Note: Authority G.S. 113A-164.6 through 113A-164.10; Eff. January 1, 1986; Amended Eff. August 1, 1988.

15A NCAC 12H .0307 EXTINGUISHMENT BY THE STATE

(a) Articles of dedication may be extinguished by amendment and the dedication abandoned when the qualifying features of the land have been destroyed or irretrievably damaged and the public purposes of the dedication have been utterly frustrated and then only after a public hearing with notice provided as described in Rule .0306(a) of this Section and only then with the concurrence of the Governor and Council of State.

(b) Where articles of dedication are proposed to be extinguished for other reasons, the State must find that the extinguishment and abandonment serves an imperative and unavoidable public necessity and that no prudent alternative exists, and then only after a public hearing with notice provided as described in Rule .0306(a) and only then with the concurrence of the Governor and Council of State.

(c) After the public hearing, the State shall publish a statement of its findings in the newspaper(s) of largest circulation in the county(ies) where the land lies at least 30 days before the extinguishment is final.

History Note: Authority G.S. 113A-164.4; 113A-164.6(c).; Eff. January 1, 1986.

15A NCAC 12H .0308 MUTUAL TERMINATION

(a) Articles of dedication may terminate in accordance with the terms of the articles of dedication itself or in accordance with the nature and duration of the underlying legal interest in the property being placed under the articles of dedication.

(b) Articles of dedication may be terminated upon mutual written consent executed by and between the owner, its successors or assigns, and the State.

History Note: Authority G.S. 113A-164.4; 113A-164.6(c).; Eff. January 1, 1986.

SECTION .0400 - MANAGEMENT: USE: AND PROTECTION OF DEDICATED NATURE PRESERVES

15A NCAC 12H .0401 MANAGEMENT PLAN

A management plan shall be prepared for each dedicated nature preserve. The articles of dedication shall assign responsibility for the preparation of the management plan. The Secretary of the Department of Natural Resources and Community Development shall have responsibility for approval of all management plans and their revisions. The Secretary or his designee shall monitor all dedicated preserves and report violations of the approved plan or other situations that may violate the articles of dedication or which may be harmful to the natural resources of the preserve. In the event that the owner or the agency managing the dedicated preserve does not adopt an approved management plan or does not adhere to the provisions of the plan, the Secretary may request the Department of Administration to take appropriate action, which may include, but is not limited to, mediation, reallocation, or referral to the Office of the Attorney General.

History Note: Authority G.S. 113-3; 113-8; 113A-164; 113A-164.4; 113A-164.7; 143-341; 143-342; Eff. January 1, 1986.

15A NCAC 12H .0402 MANAGEMENT PRINCIPLES

The following management principles shall apply for all dedicated preserves, unless exceptions are expressly provided in the articles of dedication.

(1) The essential natural character of the property shall be maintained.

(2) Improvements -- including building of all types, trails, parking areas, vehicular roadways, signs, fences, steps and bridges -- shall only be constructed when necessary for the security, safety, information, or access of the public and those improvements necessary for maintenance and management of the preserve.

(3) Destruction of flora and fauna shall not be permitted except for purpose of preserving or regenerating species and natural communities of concern, or for purpose of establishing and maintaining public access facilities. In case of either exception, manipulation of the flora and fauna shall be consistent and compatible with the natural character of the area and shall not be seriously damaging or detrimental to the natural quality of the preserve.

(4) No motorized vehicles shall be permitted on the dedicated property other than those utilized by the owner or the owner's agents in management and protection of the property, or used by the general public for ingress and egress to the property in compliance with the management plan for the preserve.

(5) No signs, billboards or other advertising of any kind shall be erected, with exception for informational and directional signs related to the designation of the area as a preserve and related to the public access to the preserve.

(6) No change shall be made in the general topography of the preserve except for those minimal alterations which may be necessary to provide on-foot access to the public for visitation or observation; this shall be done only where wholly compatible and consistent with the character of the property and where no detrimental effect shall result.

(7) No activity shall be allowed which might pollute any stream or body of water in the preserve.

(8) No stream in the preserve shall be dammed, impounded, or have its course altered.

(9) Visitor activities shall be controlled to prevent significant disturbance and environmental degradation to the preserve.

(10) Prescribed fire and necessary firelines may be used as management tools in such areas or situations where needed to maintain or protect the natural community type.

(11) The cutting or removal of trees, dead or alive, is prohibited, except that which is expressly permitted by an approved management plan or is necessary for public safety.

(12) Persons wishing to engage in scientific research or collection of natural materials within a preserve shall first secure written permission from the owner and/or the management agency.

(13) When necessary and feasible, boundaries of a preserve shall be made clearly evident by placing markers or boundary signs at corners and/or other strategic locations.

(14) Control of exotic (non-native) species may be undertaken where eradication can be accomplished without undue disturbance of natural conditions or without requiring relatively long periods of time for natural restoration.

(15) No other acts or uses which are detrimental to the maintenance of the property in its natural condition shall be allowed including, but not limited to, disturbance of the soil, mining, commercial or industrial uses, timber harvesting, ditching and draining, or depositing waste materials.

History Note: Authority G.S. 113A-164; 113A-164.4; 113A-164.7; Eff. January 1, 1986.

15A NCAC 12H .0403 MANAGEMENT RULES FOR PRESERVES

Additional management rules consistent and compatible with the general management principles for all dedicated preserves may be adopted by those divisions of the Department of Natural Resources an Community Development to which dedicated preserves are allocated for management. Such additional management rules shall be contained in the Division's administrative manual.

History Note: Authority G.S. 113-3; 113-8; 113A-164; 113A-164.4; 113A-164.7; Eff. January 1, 1986.

Nature Preserves Act.

§ 113A-164.1. Short title.

This Article shall be known as the Nature Preserves Act. (1985, c. 216, s. 1.)

§ 113A-164.2. Declaration of policy and purpose.

(a) The continued population growth and land development in North Carolina have made it necessary and desirable that areas of natural significance be identified and preserved before they are destroyed. These natural areas are irreplaceable as laboratories for scientific research, as reservoirs of natural materials for uses that may not now be known, as habitats for plant and animal species and biotic communities, as living museums where people may observe natural biotic and environmental systems and the interdependence of all forms of life, and as reminders of the vital dependence of the health of the human community on the health of the other natural communities.

(b) It is important to the people of North Carolina that they retain the opportunity to maintain contact with these natural communities and environmental systems of the earth and to benefit from the scientific, aesthetic, cultural, and spiritual values they possess. The purpose of this Article is to establish and maintain a State Registry of Natural Heritage Areas and to prescribe methods by which nature preserves may be dedicated for the benefit of present and future citizens of the State. (1985, c. 216, s. 1.)

§ 113A-164.3. Definitions.

As used in this Article, unless the context requires otherwise:

(1) "Articles of dedication" means the writing by which any estate, interest, or right in a natural area is formally dedicated as a nature preserve as authorized in G.S. 113A-164.6.

(2) "Dedicate" means to transfer to the State an estate, interest, or right in a natural area in any manner authorized in G.S. 113A-164.6.

(3) "Natural area" means an area of land, water, or both land and water, whether publicly or privately owned, that (i) retains or has reestablished its natural character, (ii) provides habitat for rare or endangered species of plants or animals, (iii) or has biotic, geological, scenic, or paleontological features of scientific or educational value.

(4) "Nature preserve" means a natural area that has been dedicated pursuant to G.S. 113A-164.6.

(5) "Owner" means any individual, corporation, partnership, trust, or association, and all governmental units except the State, its departments, agencies or institutions.

(6) "Registration" means an agreement between the Secretary and the owner of a natural area to protect and manage the natural area for its specified natural heritage resource values.

(7) "Secretary" means the Secretary of Environment and Natural Resources. (1985, c. 216, s. 1; 1989, c. 727, s. 218(68); 1989 (Reg. Sess., 1990), c. 1004, s. 19(b); 1997-443, s. 11A.119(a).)

§ 113A-164.4. Powers and duties of the Secretary.

The Secretary shall:

(1) Establish by rule the criteria for selection, registration, and dedication of natural areas and nature preserves.

(2) Cooperate or contract with any federal, State, or local government agency, private conservation organization, or person in carrying out the purposes of this Article.

(3) Maintain a Natural Heritage Program to provide assistance in the selection and nomination for registration or dedication of natural areas. The Program shall include classification of natural heritage resources, an inventory of their locations, and a data bank for that information. The Program shall cooperate with the Department of Agriculture and Consumer Services in the selection and nomination of areas that contain habitats for endangered and rare plant species, and shall cooperate with the Wildlife Resources Commission in the selection and nomination of areas that contain habitats for endangered and rare animal species. Information from the natural heritage data bank may be made available to public agencies and private persons for environmental assessment and land management purposes. Use of the inventory data for any purpose inconsistent with the Natural Heritage Program may not be authorized. The Program shall include other functions as may be assigned for registration, dedication, and protection of natural areas and nature preserves.

(4) Prepare a Natural Heritage Plan that shall govern the Natural Heritage Program in the creation of a system of registered and dedicated natural areas.

(5) Publish and disseminate information pertaining to natural areas and nature preserves within the State.

(6) Appoint advisory committees composed of representatives of federal, State, and local governmental agencies, scientific and academic institutions, conservation organizations, and private business, to advise him on the identification, selection, registration, dedication, and protection of natural areas and nature preserves.

(7) Submit to the Governor and the General Assembly a biennial report on or before February 15, 1987, and on or before February 15 of subsequent odd-numbered years describing the activities of the past biennium and plans for the coming biennium, and detailing specific recommendations for action that the Secretary deems necessary for the improvement of the Program. (1985, c. 216, s. 1; 1987, c. 827, s. 152; 1997-261, s. 82.)

§ 113A-164.5. Registration of natural areas.

(a) The Secretary shall maintain a State Registry of voluntarily protected natural areas to be called the North Carolina Registry of Natural Heritage Areas. Registration of natural areas shall be accomplished through voluntary agreement between the owner of the natural area and the Secretary. State-owned lands may be registered by agreement with the agency to which the land is allocated. Registration agreements may be terminated by either party at any time, and termination removes the area from the Registry.

(b) A natural area shall be registered when an agreement to protect and manage the natural area for its specified natural heritage resource value has been signed by the owner and the Secretary. The owner of a registered natural area shall be given a certificate signifying the inclusion of the area in the Registry. (1985, c. 216, s. 1.)

§ 113A-164.6. Dedication of nature preserves.

(a) The State may accept the dedication of nature preserves on lands deemed by the Secretary to qualify as outstanding natural areas. Nature preserves may be dedicated by voluntary act of the owner. The owner of a qualified natural area may transfer fee simple title or other interest in land to the State. Nature preserves may be acquired by gift, grant, or purchase. Dedication of a preserve shall become effective only upon acceptance of the articles of dedication by the State. Articles of dedication shall be recorded in the office of the register of deeds in the county or counties in which the natural area is located.

(b) Articles of dedication may:

(1) Contain restrictions and other provisions relating to management, use, development, transfer, and public access, and may contain any other restrictions and provisions as may be necessary or advisable to further the purposes of this Article;

(2) Define, consistently with the purposes of this Article, the respective rights and duties of the owner and of the State and provide procedures to be followed in case of violation of the restrictions;

(3) Recognize and create reversionary rights, transfers upon conditions or with limitations, and gifts over; and

(4) Vary in provisions from one nature preserve to another in accordance with differences in the characteristics and conditions of the several areas.

(c) Subject to the approval of the Governor and Council of State, the State may enter into amendments of any articles of dedication upon finding that the amendment will not permit an impairment, disturbance, use, or development of the area inconsistent with the purposes of this Article. If the fee simple estate in the nature preserve is not held by the State under this Article, no amendment may be made without the written consent of the owner of the other interests therein. (1985, c. 216, s. 1.)

§ 113A-164.7. Nature preserves held in trust.

Lands dedicated for nature preserves pursuant to this Article are held in trust by the State for those uses and purposes expressed in this Article for the benefit of the people of North Carolina. These lands shall be managed and protected according to regulations adopted by the Secretary. Lands dedicated as a nature preserve pursuant to G.S. 113A-164.6 may not be used for any purpose inconsistent with the provisions of this Article, or disposed of, by the State without a finding by the Governor and Council of State that the other use or disposition is in the best interest of the State. (1985, c. 216, s. 1.)

§ 113A-164.8. Dedication of state-owned lands to nature preserves; procedures.

Subject to the approval of the Governor and Council of State, state-owned lands may be dedicated as a nature preserve. State-owned lands shall be dedicated by allocation pursuant to the provisions of G.S. 143-341(4)g. Lands dedicated pursuant to this section may be removed from dedication upon the approval of the Governor and Council of State. (1985, c. 216, s. 1.)

§ 113A-164.9. Dedication of preserves by local governmental units.

All local units of government may dedicate lands as nature preserves by transfer of fee simple title or other interest in land to the State. (1985, c. 216, s. 1.)

§ 113A-164.10. Acquisition of land by State.

All acquisitions or dispositions of an interest in land by the State pursuant to this Article shall be subject to the provisions of Chapter 146 of the General Statutes. (1985, c. 216, s. 1.)

§ 113A-164.11. Assessment of land subject to permanent dedication agreement.

For purposes of taxation, privately owned land subject to a nature preserve dedication agreement shall be assessed on the basis of the true value of the land less any reduction in value caused by the agreement. (1985, c. 216, s. 1.)

Subject: Dedication of Portions of the (GAMELAND NAME) (IN BOLD), (COUNTY NAME) (NOT IN BOLD)

Gentlemen:

Pursuant to Article 9A, Chapter 113A of the North Carolina General Statutes, this letter of allocation is executed for the purpose of dedicating the State-owned lands hereinafter described as a North Carolina Nature Preserve

These real properties are (OR THIS REAL PROPERTY IS) currently administered by the North Carolina Wildlife Resources Commission as a portion of the (GAMELAND NAME) and consist (OR CONSISTS) of approximately (NUMBER OF ACRES) acres located in (COUNTY NAME) County, all of which are specifically described in Exhibit (EXHIBIT REFERENCE), attached hereto and by reference made a part hereof. The dedicated land shall be known collectively as the (NATURE PRESERVE NAME IN CAPITALS AND BOLD).

The terms of the grant agreement between the North Carolina Wildlife Resources Commission and the Natural Heritage Trust Fund require dedication of the qualified portions of the tract acquired as state lands with grants from the Fund.

EXHIBIT A

(DNP NAME) DEDICATED NATURE PRESERVE

DESCRIPTION

COUNTY: (COUNTY NAME) County TOPO QUAD: (QUAD NAME) 7.5'

SIZE OF AREA: ca. (NUMBER OF ACRES) acres total

(primary area (NUMBER OF ACRES) acres; buffer area (NUMBER OF ACRES) acres)

OWNER/ADMINISTRATOR: State of North Carolina

Wildlife Resources Commission

LOCATION: (DESCRIPTION OF LOCATION AND ACCESS; SEE COVE CREEK FOR EXAMPLE); see Maps (MAP NUMBERS)

DESCRIPTION: (SEE COVE CREEK FOR EXAMPLE)

MANAGEMENT AND USE: The dedicated nature preserve is a portion of the (NUMBER OF ACRES)-acre (GAMELAND NAME) owned by the State or leased from private owners. (STATEMENT INDICATING PUBLIC USE OF GAMELAND AND ADJOINING WATERS; SEE COVE CREEK FOR EXAMPLE).

THIS DEDICATION OF THE (DNP NAME) NATURE PRESERVE IS MADE SUBJECT TO THE FOLLOWING TERMS AND CONDITIONS:

1. As used in this Letter, the terms "natural area" and "nature preserve" shall have the same meaning as contained in North Carolina General Statutes, Section 113A-164.3.

2. Pursuant to North Carolina General Statutes 113-164.8, all State-owned lands lying within the above designated area(s) are hereby dedicated as a nature preserve to be known collectively as the (DNP NAME) Nature Preserve (hereinafter "preserve") for the purposes provided in the North Carolina Nature Preserves Act, as amended, and other applicable law, and said State-owned land, shall be held, maintained, and used exclusively for said purposes.

3. **Primary Custodian**: The primary custodian of the preserve will be the North Carolina Wildlife Resources Commission, which will be responsible for managing the preserve in accordance with State Administrative Code 15 NCAC 12H.300.

4. **Primary Classification**: The primary classifications and purposes of the preserve will be conservation, nature education, wildlife management, hunting, fishing, trapping, and other recreational uses authorized by the Primary Custodian. The ecological significance of the preserve is described in Exhibit (EXHIBIT REFERENCE).

5. **Management Areas:** For the purposes of management, the preserve shall be considered to consist of a Primary Area (approximately (INSERT PRIMARY AREA ACREAGE) acres) and a Buffer Area (approximately (INSERT BUFFER AREA ACREAGE) acres), as more particularly described in Exhibit (EXHIBIT REFERENCES), attached thereto and by this reference made a part hereof. The Primary Area consists essentially of the (BRIEF VERBAL DESCRIPTION).

   The Primary Area is deemed by the Secretary of the North Carolina Department of Environment and Natural Resources to qualify as an outstanding natural area under statutory criteria for nature preserve dedication (G.S. 113A-164.6) and further serves all of the public purposes for a dedicated preserve as stated in Administrative Rules 15 NCAC 12H.0301(b).

   The Buffer Area, which contributes to the management and protection of the Primary Area, consists of (BRIEF VERBAL DESCRIPTION):

6. **Rules for Management of the Primary Area(s)**:

A. Character of Visitor Activity: The principal visitor activities in the preserve shall be hunting, fishing, trapping, walking, research, and observation. These activities shall be regulated by the Custodian to prevent significant disturbance of the preserve. These activities may specifically be regulated by the Custodian to protect and conserve the natural values of the preserve.

Activities and uses unrelated to those listed above are prohibited except as otherwise provided in these Articles or unless necessary to carry out the purposes of the preserve. Prohibited activities include, but are not limited to: construction; commercial activities and development; commercial silviculture; agriculture and grazing; gathering of native species of plants or plant products; the removal, disturbance, molestation, or defacement of minerals, archaeological and natural resources, except for research purposes as approved by the Custodian; and those activities specifically restricted in these Articles.

There shall be no fires, except as necessary for ecological management of the preserve or in conjunction with supervised educational activities of the Custodian, or further excepted as herein provided or otherwise expressly permitted.

B. Consumptive Wildlife Uses: Hunting, fishing, and trapping shall be permitted on the preserve subject to regulations and management by the North Carolina Wildlife Resources Commission.

C. Orientation and Guidance of Visitors: The Custodian reserves the right to orient and guide visitors for educational programs, hunting and fishing uses, scientific research, and for preserve management. Exhibits, programs, and printed materials may be provided by the Custodian in service areas. The Custodian may restrict access to visitors in those instances or in such areas that restrictions may be determined necessary to safeguard sensitive environmental resources in the preserve.

D. Disturbance of Natural Resources: The cutting or removal of trees, dead or alive, or the disturbance of other natural resources is prohibited except as necessary for removal of hazards to visitors, control of disease that would damage or reduce the significance of the preserve, restoration after severe storm damage, trail clearance and maintenance, or for purposes of maintenance or restoration of natural communities or rare species populations as stipulated in the preserve management plan and that which is consistent with the purposes of these Articles. Salvage timber cuts which may be necessary due to

natural catastrophe will be allowed in both Primary and Buffer Areas, but in a manner that will contribute to the recovery of the prevailing natural conditions of the forest and in consultation with the North Carolina Natural Heritage Program.

E. Wild Fire Control: Wild fires may mimic natural processes historically occurring in an ecosystem on a landscape level. When the extent of a wild fire does not threaten human life or structures, it may be allowed to burn with minimal control. If wild fire control is necessary, firebreaks may need to be established. When possible, existing roads and firebreaks will be utilized for wild fire control. When new firebreaks need to be established, environmentally sensitive areas will be avoided when possible. Old firebreaks which affect the natural hydrology of wetlands will be filled and allowed to revegetate. Planning of firebreak restoration should occur in consultation with the North Carolina Natural Heritage Program.

F. Water Control: The purpose of water control shall be to maintain the preserve's natural water regime. Water levels that have been altered by man may be changed if necessary to restore the preserve to its natural condition. In a preserve with a long history of managed hydrology, water levels may be managed to perpetuate the ecosystems that have evolved around the hydrology or may be restored to natural condition. This decision should be made in consultation with the Natural Heritage Program. Millponds are an example of situations in which water levels have been historically managed.

G. Pollution and Dumping: There will be no storage or dumping of ashes, trash, garbage, hazardous substances, toxic waste, other unsightly or offensive material, or fill material, including dredge spoil in, on, or under the preserve. No underground storage tanks may be placed within the preserve. No surface or ground waters of the preserve may have pollutants added within the preserve.

H. Control of Vegetational Succession: Control of vegetational succession may be undertaken if necessary to maintain or restore a particular natural ecosystem type or to preserve endangered, threatened, rare, or other unusual species. Controls will be done in the manner that best imitates the natural forces believed responsible for maintaining the natural ecosystem type, or that minimizes unnatural effects on non-target portions of the ecosystem. Prescribed burning is particularly essential to ecosystems where natural wild fire historically suppressed woody vegetation and promoted herbaceous diversity.

I. Control of Populations: Any control of animal or plant populations on the preserve shall be for the purpose of correcting those situations where those populations are significantly

affecting natural conditions on the preserve, and in accordance with the Custodian's established regulations for hunting, trapping, or fishing of designated game animals. The Custodian may, in consultation with the North Carolina Natural Heritage Program, apply biological controls, herbicides and pesticides, and other means deemed necessary or appropriate to control or eradicate exotic or native species of plant or animal that are degrading the natural character of the preserve. Because of potential impacts on native species, no exotic flora or fauna shall be introduced into the preserve.

J. Research and Collecting Permits: Any person wishing to engage in scientific research requiring collecting or otherwise affecting anything within the preserve shall first secure written permission from the Custodian.

K. Roads and Trails: Construction and maintenance of roads, trails, and other access structures within Primary and Buffer Areas of the preserve will be limited to the level necessary to appropriately manage the preserve. New roads shall not be constructed in the Primary area (SPECIFIC EXCEPTIONS STATED HERE IF ABSOLUTELY NECESSARY). When necessary, the Custodian may construct and maintain access limited to staff use for management purposes, such as service paths (single lane vegetated paths) for patrol, right-of-way maintenance, and other management activities, within the Primary Area. Number and width of new paths will be minimized, and sensitive areas avoided when possible. Existing roads that occur within or form a boundary of the Primary Area may be maintained by grading of the roadbed, replacing culverts, or adding stone as needed in order to maintain the integrity of the road for vehicular use. Daylighting of roads within the Primary Area should be minimized, but may be used if necessary to maintain the condition of the road. Access management and construction will be part of the overall management planning process and will include consultation with the North Carolina Natural Heritage Program.

(OPTIONAL, TO BE INSERTED IF ROADSIDE POPULATIONS ARE SO SIGNIFICANT THAT THEY MERIT PROTECTION):

Populations of certain rare species requiring open or wet habitats sometimes become established in artificially maintained habitats, such as road banks and ditches. The processes that create and maintain these habitats, such as mowing and keeping the ditches open, must be carefully planned and timed to allow these rare populations to persist and eventually spread to more natural habitats. Under these circumstances, maintenance activities should be planned in consultation with the North Carolina Natural Heritage Program.

L. Other Structures and Improvements: Structures or facilities shall not be erected by the Custodian within a preserve, except as may be consistent with the purposes of the preserve as stated in this dedication. Site selection shall be consistent with this dedication.

M. Management Plan: The Wildlife Resources Commission, as Primary Custodian of the preserve, shall be required to prepare and submit for approval to the Secretary of the Department of Environment and Natural Resources a management plan for the preserve. The management plan will be part of the larger management plan developed for the gamelands. This plan shall be subject to all the provisions of this dedication and shall additionally be consistent with the management principles set forth in the North Carolina Administrative Code 15 NCAC 12H.0300 and such other regulations as may be established from time to time by the Secretary of the Department of Environment and Natural Resources. In any case where contradictions may arise between this instrument of dedication and other management regulations, the terms of this dedication shall take precedence.

7. **Rules for Management of the Buffer Area(s)**: Primary area rules also apply to buffer areas except that forestry and wildlife management activities may be planned and carried out as needed. These activities will be conducted in accordance with policy of the N.C. Wildlife Resources Commission and general management philosophy as outlined in Commission planning documents. These rules and guidelines require the protection and enhancement of wildlife populations and habitat so that hunting, fishing, trapping and other wildlife recreational opportunities are available to citizens of this State. Forest management is primarily conducted to enhance wildlife habitat. Based on these general objectives, the following buffer functions will be addressed in the management plan: 1) retention of naturally occurring plant and animal species, 2) maintenance of habitat connectivity and continuity, 3) management needs of rare animal and plant species populations occurring within the buffer area, and 4) protection of soil and hydrologic resources. Management plans will be reviewed, as appropriate, by the Natural Heritage Program staff to ensure that the integrity of the Nature Preserve is protected.

* “Retaining naturally occurring plant and animal species assemblages, to the extent that they are known” primarily includes the following:

a) avoidance of type conversion of forest canopy, except in instances where type conversion restores the canopy to a more natural composition;

b) avoidance of introduction of invasive exotics, which damage the integrity of the naturally occurring herbaceous layer; and

c) minimization of direct mechanical or chemical impacts to the naturally occurring herbaceous layer.

** “Maintenance of habitat connectivity and continuity” primarily includes the following:

a) preservation of functional riparian corridors;

b) preservation of functional connecting corridors between primary areas within the dedicated area and to high quality natural areas outside the dedicated area;

c) in planning active management, utilization of methods which most closely approximate natural processes when possible;

d) in planning active management, retention of other habitat features which serve specific wildlife functions (see Wetland Forestry and Wildlife Management section of draft 1996 Best Management Practices for Forestry in North Carolina’s Wetlands).

8. **Amendment and Modification**: The terms and conditions of this dedication may be amended or modified upon agreement of the Wildlife Resources Commission and Secretary of the Department of Environment and Natural Resources, and approved by the Council of State. Any portion of the tract dedicated pursuant to this instrument may be removed from dedication in accordance with the provisions of North Carolina General Statutes 113A-164.8.

9. **Permanent Plaque**: The Custodian should erect and maintain a permanent plaque or other appropriate marker at a prominent location within the preserve bearing the following statement: "This Area is Dedicated as a State Nature Preserve."

The Governor and Council of State have approved the dedication of the State-owned lands hereinabove described as the (NAME OF NATURE PRESERVE) (IN BOLD) to be held in trust by the Custodian for the uses and purposes expressed in the Nature Preserves Act at a meeting held in the City of (City Name), North Carolina, on the _____ of _____, (YEAR). (TYPE IN DATE AFTER COUNCIL OF STATE APPROVAL)

Sincerely,

Gwynn T. Swinson

GTS/(INITIALS OF SECRETARY)

CONSENTED AND AGREED TO:

_____

Secretary

Department of Environment and Natural Resources

_____

Executive Director

Wildlife Resources Commission

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