Rough-leaved Loosestrife (*Lysimachia asperulaefolia*)

5-Year Review:
Summary and Evaluation

USFWS photo, D. Suiter

U.S. Fish and Wildlife Service
Southeast Region
Raleigh Ecological Services Field Office
Raleigh, North Carolina

5-YEAR REVIEW
Rough-leaf Loosestrife (*Lysimachia asperulaefolia*)

I. GENERAL INFORMATION

A. Methodology used to complete the review

The information used to prepare this report was gathered from peer-reviewed scientific publications, status surveys by Carter (1985) and Bates (2001), current data from the North Carolina Natural Heritage Program (NCNHP) and the South Carolina Heritage Trust Program (SCHTP), correspondence from botanists who are knowledgeable of the species, unpublished reports and personal field observations. The review was completed by the lead recovery biologist for *Lysimachia asperulaefolia* in the Raleigh, North Carolina Ecological Services Field Office. The recommendations resulting from this review are a result of thoroughly assessing the best available information on *Lysimachia asperulaefolia*. Comments and suggestions regarding the review were received from peer reviews within and outside the U.S. Fish and Wildlife Service (USFWS). A detailed summary of the peer review process is provided in Appendix A. No part of the review was contracted to an outside party. Public notice of this review was provided in the *Federal Register* on July 29, 2008 (73 FR 43947), and a 60-day public comment period was opened. No comments were received. During the process of completing this review, specific questions were asked of various land managers and biologists who work with this species.

B. Reviewers

Lead Region:
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Lead Field Office:
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C. Background

1. Federal Register Notice citation announcing initiation of this review:

July 29, 2008 (73 FR 43947)

2. Species status:

Based on the recent analysis of long-term monitoring data from metapopulations that roughly correspond with the nine population centers identified in the recovery criteria of the Recovery Plan, it appears that, overall, the species is declining. No monitoring occurred at one of the originally identified population centers (Pamlico/Beaufort counties) because no plants have been observed there since 1990. Protected sites within 10

metapopulations (62 subpopulations) across the species' range have been monitored since 2000 in order to assess species trends using Population Viability Analysis (PVA). Preliminary PVA results indicate that two metapopulations are increasing, two are stable and five are declining. The status of one metapopulation is unknown because monitoring has not occurred at that site. Further data analysis will determine how prescribed fires affect short-term growth rates and develop quasi-extinction thresholds to predict long-term viability for subpopulations and metapopulations (Robinson and Buchanan 2014).

3. Recovery achieved:

Approximately 26 – 50 % of the recovery objectives have been achieved. According to Robinson and Buchanan (2014) only four of the 11 metapopulations are stable or increasing. We have five or more years of monitoring data for nine of the 11 metapopulations. Management plans that meet the recovery criteria as defined in the Recovery Plan have been prepared for only five of the 11 metapopulations. Additional discussion about the progress of recovery accomplishments follows in section II.B.

4. Listing history:

Original Listing
FR notice: 52 FR 22585
Date listed: June 12, 1987
Entity listed: species
Classification: endangered

5. Associated rulemakings:

There are no associated rulemakings.

6. Review History:

Lysimachia asperulaefolia was listed as endangered in 1987. Status surveys for this species were completed in 1985 and 2001. In 1985, Carter (1985) conducted the first status survey and visited 15 populations throughout the coastal plain and sandhills of NC and SC. The USFWS contracted with the NCNHP to update the original status survey for this species (Bates 2001). These field surveys were conducted during 1999 and 2000 which confirmed 29 populations. The element occurrences at Fort Bragg, Camp Lejeune and Croatan National Forest were not updated during this field work. Please note that the term "population" used here may not be equivalent to the current use of the term as defined by NatureServe standards. This is further explained in section II.B.3.

Recovery Plan: 1995
Recovery Data Call: 2013 - 1998

The USFWS conducted a 5-year review for *Lysimachia asperulaefolia* in 1991 (56 FR 56882). In that review, the status of many species was simultaneously evaluated with no in-depth assessment of the five factors or threats as they pertain to the individual species. The notice stated that the USFWS was seeking any new or additional information reflecting the necessity of a change in the status of the species under review. The notice indicated that if significant data were available warranting a change in a species' classification, the USFWS would propose a rule to modify the species' status. No new information or additional data was received for *Lysimachia asperulaefolia*. Therefore, no change in the plant's listing classification was found to be appropriate.

7. Species' Recovery Priority Number at start of review (48 FR 43098):

Lysimachia asperulaefolia has been assigned a recovery priority number of 8, indicating a moderate degree of threat, a high potential for recovery, and a taxonomic status of full species.

8. Recovery Plan:

The *Lysimachia asperulaefolia* Recovery Plan was approved on April 19, 1995.

II. REVIEW ANALYSIS

A. Application of the 1996 Distinct Population Segment (DPS) policy

The Endangered Species Act (Act) defines species as including any subspecies of fish or wildlife or plants, and any distinct population segment of any species of vertebrate wildlife. This definition limits listing DPSs to only vertebrate species of fish and wildlife. Because the species under review is a plant and the DPS policy is not applicable, it is not addressed further in this review.

B. Recovery Criteria

1. Does the species have a final, approved Recovery Plan containing objective, measurable criteria? Yes

2. Adequacy of recovery criteria

a. Do the recovery criteria reflect the best available and most up-to-date information on the biology of the species and its habitat? Yes.

b. Are all of the 5 listing factors that are relevant to the species addressed in the recovery criteria? No

The recovery criteria outlined in the Recovery Plan doesn't specifically address overutilization of the species for commercial, recreational, scientific, or educational purposes or disease and predation. However, these were not significant threats at the time of listing, nor are they at this time.

3. List the recovery criteria as they appear in the Recovery Plan, and discuss how each criterion has or has not been met, citing information.

Lysimachia asperulifolia will be considered for reclassification from endangered to threatened when:

1. Management plans have been prepared and are being implemented for all publicly owned population centers and those owned by The Nature Conservancy, and [Status: partially complete]
2. Populations at these centers have been monitored for at least five years and are determined to be stable. [Status: partially complete]

Lysimachia asperulaefolia will be considered for delisting when the above conditions are met and a binding management agreement for each population center is in place. [Status: partially complete]

There are 10 metapopulations that are publicly owned or in conservation ownership: Bladen Lakes Area, Boiling Springs Lakes, Camp Lejeune, Croatan National Forest, Fort Bragg/Camp Mackall, Green Swamp Nature Preserve, Holly Shelter Game Lands, Sandhills Gamelands, South Carolina Sandhills (Fort Jackson) and Military Ocean Terminal Sunny Point. These sites roughly coincide with the population centers listed in the Recovery Plan. The one exception to this is the Pamlico and Beaufort counties population center where *Lysimachia asperulaefolia* plants haven't been seen since 1990.

Criterion 1 is only partially complete because management plans that meet the Recovery Plan criteria have been prepared for only 5 of the 10 metapopulations: Camp Lejeune, Croatan National Forest, Fort Bragg/Camp Mackall, Green Swamp Nature Preserve and Military Ocean Terminal Sunny Point. Criterion 2 is also only partially complete because monitoring data has been collected for more than five years at nine of the 10 population centers, the exception being the Bladen Lakes Area. Further, many of the population centers have been monitored for 10 years or more. A Population Viability Analysis was prepared for this species based on this long term monitoring data. The results of this analysis indicate that the trends at only two population centers are stable and two are increasing. The trends at five population centers are believed to be declining and the trend at the remaining site is unknown because insufficient monitoring has been conducted (Robinson and Buchanan 2014). The USFWS has encouraged

land managers to continue monitoring in order to better understand population trends and guide management actions that will benefit the species.

Each population center listed in the Recovery Plan consists of one or more subpopulations. Some subpopulations are grouped together as part of one population, depending on NatureServe's separation distance criteria. For example, subpopulations of *Lysimachia asperulaefolia* that occur within 2 kilometers of each other are considered part of the same population.

C. Updated Information and Current Species Status

1. Biology and Habitat:

a. Abundance, population trends, demographic features, or demographic trends:

Status surveys for *Lysimachia asperulaefolia* were conducted in 1985 (Carter 1985) and in 1999 and 2000 (Bates 2001). As part of the latter status survey, Bates developed monitoring protocols; and, with the help of the appropriate land managers, successfully implemented a long-term monitoring program at several protected populations. These protocols allow for three levels of monitoring and each land manager initially chose which level of monitoring would work best for their situation. Appendix B includes a complete description of these monitoring protocols.

Since 2000, land managers have monitored sub-populations at 62 different sites within nine population centers. Kristopher Voss, a Duke University graduate student, conducted a preliminary PVA using Bayesian State-Space Models on the monitoring data collected from 2000 to 2012. Based on his analysis, it appears that two populations are increasing, two populations are stable, five populations are estimated as declining and the trends at one population are undeterminable with the current amount of monitoring data available. This analysis is summarized in Robinson and Buchanan (2014).

b. Genetics, genetic variation, or trends in genetic variation:

Based on pollination and seed production studies, Frantz (1984) determined that *Lysimachia asperulaefolia* is an obligate outcrossing species. Seed production is low since populations are highly fragmented, reducing the chances of cross pollination by the few pollinators that are present.

According to Franklin (2001), low seed production within populations supports the conclusion that populations contain little to

no genetic diversity. Since flowers are self- incompatible and there appear to be few pollinators present, there is generally low seed production. Further, there appears to be a low proportion of individuals that flower in some populations in any given year.

Edwards (2007) used isozymes and AFLPs to assess the levels and distribution of population genetic variation. According to this research, *Lysimachia asperulaefolia* apparently has extremely low levels of population genetic variation, indicating that this species has likely gone through a series of severe population bottlenecks prior to its current fragmented distribution.

c. Taxonomic classification or changes in nomenclature:
Lysimachia asperulaefolia was described by Jean Louis Marie Poiret in 1814. Since listing as endangered in 1987, there have been no changes to the nomenclature of the species, however some references now spell the specific epithet as "*asperulifolia"* an orthographic variant of *"asperulaefolia*." In addition, in the listing documents and the Recovery Plan, the common name is referred to as Rough-leaved Loosestrife; however, some references use the common name Rough-leaf Loosestrife. Ironically, the leaves are actually smooth in texture.

The genus *Lysimachia* is now considered to be part of the Myrsinaceae family and not the Primulaceae family (Weakley 2012).

d. Spatial distribution, trends in spatial distribution, or historic range:
When the Recovery Plan was written in 1995, *Lysimachia asperulaefolia*, was reported from 13 counties in the coastal plain and sandhills of North Carolina (NC) and two counties in the sandhills of South Carolina (SC). Since then, the species has been extirpated in Beaufort and Richmond counties in NC and Darlington County in SC; however, new populations have been found in New Hanover and Craven Counties in NC. Currently, the species is believed to be extant in 12 NC counties. Despite intensive surveys throughout the coastal plain and sandhills of SC, this species is only known from Fort Jackson Army Base in Richmond County. A total of 148 Element Occurrences (populations or subpopulations) are currently extant in NC and 19 more EOs in NC are currently ranked F, indicating that botanists have "Failed to Find" this species at sites where it was previously known (Suzanne Mason, NCNHP, pers. comm., 2013).

e. Habitat:
All of the known *Lysimachia asperulaefolia* populations occur in the coastal plain or sandhills physiographic provinces of NC and SC. According to the Recovery Plan (USFWS 1995), this species is typically found in the ecotone between longleaf pine or oak savannas and wetter, shrubby plant communities growing on moist sand or peat. These habitats are typically maintained in an open condition by periodic fires and are often dominated by longleaf pine (*Pinus palustris*). *Lysimachia asperulaefolia* is typically associated with six natural community types: low pocosin, high pocosin, wet pine flatwoods, pine savanna, streamhead pocosin and sandhill seep. It is also found in peaty pond margins and disturbed sites such as roadside depressions, powerline rights-of-way and firebreaks. According to Frost (2006), only about 2.2 % of longleaf pine ecosystems remain compared to pre-settlement times.

f. Other relevant information:
The NC Botanical Garden is the designated Center for Plant Conservation repository for *Lysimachia asperulifolia*. Seeds from two NC populations (NCNHP EOs 139.110 and 143.010) are stored there for long term preservation of genetic material and to be used for research and reintroduction. The NC Botanical Garden hopes to increase seed accessions and conduct research on seed production, seed ecology, storage and germination as funds become available. In addition, they also have plants in cultivation from NCNHP EO 85 that are used for educational purposes (Michael Kunz, Conservation Ecologist, NC Botanical Garden, pers. comm.). The NC Botanical Garden monitors the experimental translocation of individuals that were moved from a portion of a population slated for impact by a road construction project to a NCDOT mitigation site. The experiment looks at the effectiveness of moving plants in the dormant season versus the growing season and it also considers a variety of site pre-treatments. The experiment is still within the initial 10 years of monitoring, so it is not practical to determine trends at this time. However, early results suggest a preference to dormant season translocation and some site pretreatment to reduce competition from vegetation. In addition, under USFWS oversight, Fort Bragg Army Base, the U.S. Army Engineer Development Research Center – Construction Engineering Research Laboratory (ERDC-CERL) and the NC Botanical Garden are working to reintroduce this species to historic sites on the military base. Since seed production is very low in this species, they are using sections of rhizome that were collected from nearby sites on Fort Bragg.

Summary
Status surveys for *Lysimachia asperulaefolia* were conducted in 1985 (Carter 1985) and in 1999 and 2000 (Bates 2001). Since 2000, nine different land managers have monitored 62 subpopulations. Statistical analysis indicates that the populations at two population centers are increasing, two are considered stable and five are believed to be declining. Management plans have been prepared for five populations. Genetics research indicates that *Lysimachia asperulaefolia* apparently has extremely low levels of population genetic variation, indicating that it likely has gone through a series of severe population bottlenecks prior to its current fragmented distribution history (Edwards 2007). The only change in taxonomy since listing is that the genus *Lysimachia* is now considered to be part of the Myrsinaceae family rather than the Primulaceae family.

When the Recovery Plan was written in 1995, *Lysimachia asperulaefolia*, was reported from 15 counties in NC and SC. Since then, the species has been extirpated from two counties in NC and one county in SC; however, new populations have been found in two NC counties. Currently, the species is believed to be extant in 12 NC counties and one county in SC. A total of 148 EOs (populations or subpopulations of populations) are currently extant in NC, 16 EOs are considered historic or extirpated and 19 more EOs in NC are currently ranked F as "Failed to Find."

Lysimachia asperulaefolia populations occur in the coastal plain or sandhills physiographic provinces of NC and SC. It is typically found in the ecotone between longleaf pine or oak savannas on moist sand or peat. These habitats are typically maintained in an open condition by periodic fires and are often dominated by Longleaf pine.

The NC Botanical Garden has seeds from two *Lysimachia asperulaefolia* populations in long term storage. Living plants from one additional location are being cultivated in their rare plant garden for educational purposes. Rhizomes have been transplanted to a NCDOT mitigation site and to historic sites on Fort Bragg Army Base.

2. Five-Factor Analysis:

a. Present or threatened destruction, modification or curtailment of its habitat or range:

Lysimachia asperulaefolia is threatened by habitat destruction in the form of land conversion (residential and commercial development, road construction, silviculture, wetland draining and/or filling) and fire suppression (also see Factor E below) which alters or destroys habitat where it once occurred. Herbicide use, especially on road shoulders and powerline rights of way has potential to quickly cause negative impacts to this rhizomatous perennial.

As mentioned above, parts of 10 metapopulations or population centers are in public or conservation ownership including property owned and/or managed by the Department of Defense, U.S. Forest Service, NC Wildlife Resources Commission Game Lands, NC Plant Conservation Preserves, NC Department of Transportation and The Nature Conservancy. We consider all of these populations protected from direct residential and commercial development. However, even protected sites may be impacted by NCDOT projects. For example, the Hampstead Bypass project will soon impact a portion of a *Lysimachia asperulaefolia* previously set aside as mitigation for impacts to this species on the Wilmington Bypass. Camp Lejeune Marine Corps Base also recently proposed a project that may impact *Lysimachia asperulaefolia*. Management plans have been prepared for five of the 10 metapopulations. Fire suppression and ecological succession remain significant threats to this species. As development increases in areas surrounding the preserves mentioned above, it becomes increasingly more difficult to manage those sites using fire. Without fire, these habitats grow up with dense woody vegetation that ultimately shades out herbaceous species like *Lysimachia asperulaefolia*. As mentioned in section II.C.1., long term monitoring at 10 population metapopulations shows that only two populations are stable and two are increasing. The status at five populations are declining and the status of one is unknown due to insufficient monitoring data. Additional management and monitoring is necessary to determine the best strategy for assuring that these populations are stable.

b. Overutilization for commercial, recreational, scientific, or educational purposes:

There is currently no evidence to suggest that *Lysimachia asperulaefolia* is being overutilized for commercial, recreational, scientific or educational purposes. Collections used for research purposes are permitted by the USFWS (if made on federal lands) and by the NC Plant Conservation Program (if made on private lands) and are limited to volumes of plant parts that are believed to be insignificant and will not jeopardize any particular population.

Permit requirements follow protocols developed by the Center for Plant Conservation and are protective of the species.

c. Disease or predation:
Herbivory has been observed in this species (Moloney 1985; personal observations of the author). In some cases, the main stem appears to have been severed and two to three lateral shoots grow from a node just below that point. Although no one has recorded observing any particular animals eating this plant, it seems reasonable to believe that white-tailed deer (*Odocoileus virginianus*) may be responsible for browse noticed in the field. No insect damage has been reported in this species.

d. Inadequacy of existing regulatory mechanisms:
Because of its federal endangered status, *Lysimachia asperulaefolia* is provided protections that would otherwise not occur under any other Federal, state or local law. In particular, federally funded activities with the potential to affect this species that are authorized, funded or otherwise carried out by Federal agencies are subject to section 7 consultation with the Service to ensure that such actions do not jeopardize the continued existence of the species. Section 7(a)(1) of this statute also directs Federal agencies to utilize their authorities to assist the USFWS in the recovery of species listed under this statute. Department of Defense installations such as Fort Jackson, Camp Lejeune, Fort Bragg and Military Ocean Terminal at Sunny Point all have included special provisions for the protection of this species in their respective Integrated Natural Resource Management Plans. The U.S. Army Corps of Engineers wetland alteration permits (Section 404 of the Clean Water Act) should ensure that such permits do not jeopardize the continued existence of federally protected species. In addition to the federal endangered status, the U.S. Forest Service also lists the species on its Proposed, Endangered, Threatened, and Sensitive species (PETS) list due to its presence on the Croatan National Forest. As such, the Croatan National Forest Plan requires the Forest Service to maintain the viability of the species across the National Forest Unit. Despite these federal protections, plants on private land may be impacted by the property owner as long as no other federal laws are broken in the process.

At the time of federal listing, this species was also listed as state endangered by the State of North Carolina under the Plant Protection and Conservation Act of 1979 (North Carolina Code Article 19B, § 106-202.12; NC Act). The NC Act provides limited protection from unauthorized collection and trade of plants listed under that

statute. However, the statute does not protect the species or its habitat from destruction in conjunction with development projects or otherwise legal activities (Robinson and Finnegan 2014). The NC Act authorizes the NC Plant Conservation Program to establish nature preserves for protected species and their habitat, but that agency has not yet created any nature preserves for this species.

e. Other natural or manmade factors affecting its continued existence:

At the time of listing, small population sizes and few individual plants within each population were identified as threats to this species. Populations that are small in size and number of individual plants are vulnerable to stochastic events. Fire suppression was also identified as a serious threat. The lack of fire in the habitat where this species occurs allows woody species to grow and compete for sunlight, eventually shading out this low growing species. The exclusion of fire also affects nutrient cycling and insect populations.

In addition to the two factors mentioned above, we now understand that this plant is a poor seed producer, possibly due to low genetic diversity and low pollinator visitation and efficiency. This may be the biological factor most likely to limit the species' ability to colonize new habitat and adapt to changes in the environment (Franklin 2001).

Since this species was listed, climate change and drought have been identified as new threats to the species. Current climate change predictions for terrestrial areas in the Northern Hemisphere indicate warmer air temperatures, more intense precipitation events, and increased summer continental drying (Field et al. 1999, Hayhoe et al. 2004, Cayan et al. 2006, Intergovernmental Panel on Climate Change (IPCC) 2007). Climate change may lead to increased frequency and duration of severe storms and droughts (Golladay et al. 2004, McLaughlin et al. 2002, Cook et al. 2004).

With regards to Longleaf pine savannas, the Hadley Centre model suggests that savanna and grasslands may expand and replace southeastern pine forests at some sites in the coastal plain due to increased moisture stress (America's Longleaf Regional Working Group 2009). While the effects of climate change on longleaf ecosystem plant communities have not been well studied, one report concluded that while longleaf pine might perform well with increased carbon dioxide, the herbaceous species may not compete as well (America's Longleaf Regional Working Group 2009). We are not

currently aware of any climate change information specific to *Lysimachia asperulaefolia* habitat, we do expect changes to occur.

Summary

The most important factors that justify its endangered status are related to its extreme rarity due to habitat loss from fire suppression and subsequent ecological succession. *Lysimachia asperulaefolia* sites located within utility rights-of-way are threatened by herbicide use or mowing during critical growth periods. There is currently no evidence to suggest that *Lysimachia asperulaefolia* is being overutilized for commercial, recreational, scientific or educational purposes. Herbivory has been observed in this species, most likely caused by white-tailed deer. Because of its endangered status, *Lysimachia asperulaefolia* is protected on federal lands and it is also listed as state endangered under the NC Plant Conservation Act of 1979. Climate change including increased potential for drought in areas where this species occurs is expected, but the potential affects to this species is not well understood at this time.

D. Synthesis

To summarize, status surveys for *Lysimachia asperulaefolia* were conducted in 1985 (Carter 1985) and in 1999 and 2000 (Bates 2001). Since 2000, long term monitoring has occurred at nine population centers. The trends assessed using PVA indicate that two of those populations are increasing in size and two are stable. The analysis indicates that five of the 10 monitored populations are declining and there is insufficient monitoring data from one site to determine the status (Robinson and Buchanan, 2014). Genetics research (Edwards 2007) indicates that *Lysimachia asperulaefolia* apparently has extremely low levels of population genetic variation. Taxonomically, *Lysimachia* is now considered to be a part of the Myrsinaceae family rather than the Primulaceae family. When the Recovery Plan was written in 1995, *Lysimachia asperulaefolia* was known from 58 individual sites or EOs in NC and one site in SC. Depending on their distance from other sites, many have been lumped into metapopulations. These sites occur in the coastal plain or sandhills physiographic provinces of NC and SC. Typically, this species is found in the ecotone between longleaf pine or oak savannas on moist sand or peat, communities often dominated by Longleaf pine. The NC Botanical Garden has seeds from two populations in long term storage and living plants on display for educational purposes. They have been involved in two introduction/reintroduction projects.

The most important factors that justify the endangered status of *Lysimachia asperulaefolia* include habitat loss from fire suppression and associated ecological succession. Sites located within utility and transportation rights-

of-way are threatened by herbicide use or mowing during critical growth periods. Low seed production prevents the species from effectively colonizing new areas or adapting to changes/selection pressures in the environment. *Lysimachia asperulaefolia* is not threatened by commercial, recreational, scientific or educational purposes. White-tailed deer are most likely the cause of herbivory. *Lysimachia asperulaefolia* is protected on federal lands and it is also listed as endangered under the NC Plant Conservation Act of 1979.

Despite the discovery of several new occurrences of this species since listing, monitoring at 62 sites indicates that the species is still in decline. In addition, the small number of populations and threats to the species such as fire suppression, forestry practices and the destruction or modification of habitat, we believe that the species is only moderately less endangered with extinction now than it was at the time of listing. Therefore, *Lysimachia asperulaefolia* still meets the definition of endangered under the ESA.

III. RESULTS

A. Recommended Classification:

_X_ No change is needed

IV. RECOMMENDATIONS FOR FUTURE ACTIONS

A list of recommendations for future actions that will contribute to the recovery of *Lysimachia asperulaefolia* include:

- revisit known populations that have not been visited in the past three years, especially those populations that have been ranked as F (Failed to Find) or H (Historic) in the NCNHP database; monitor the condition of the habitat at each site including threats; discuss conservation options with landowners where appropriate; report the results of these site visits to the appropriate Heritage Program,
- search for additional populations in appropriate habitat,
- prioritize known sites for protection and identify recovery populations,
- protect additional populations,
- identify those populations that would contribute the most toward recovery (self-sustaining, protected, etc.) as recovery populations,
- determine which sites have management plans and how they are being implemented,
- develop and implement management plans for all remaining protected populations,
- determine the management techniques for sustaining populations, such as fire frequency and seasonality,
- update monitoring protocols and remind land managers about their commitment to monitoring this species on their property,

- continue to analyze monitoring data using PVA or other accepted methods,
- complete a population genetic analysis as suggested by Edwards (2007),
- organize a meeting of land managers, researchers and other interested parties to discuss the long-term recovery of this species, and
- work with NC Botanical Garden to conserve germplasm and further develop propagation and transplantation protocols.

V. REFERENCES

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A complete bibliography of reports, articles, papers and books referencing *Lysimachia asperulaefolia* can be found in Appendix C.

U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW OF ROUGH-LEAF LOOSESTRIFE
(LYSIMACHIA ASPERULAEFOLIA)

Current Classification: Endangered
Recommendation resulting from the 5-Year Review:

____ Downlist to Threatened
____ Uplist to Endangered
____ Delist
__X_ No change is needed

Review Conducted By: Dale Suiter, Fish and Wildlife Biologist, Raleigh Ecological Services Field Office

FIELD OFFICE APPROVAL:
Pete Benjamin, Lead Field Supervisor, U.S. Fish and Wildlife Service

Approve _____ Date 8/22/14

for REGIONAL OFFICE APPROVAL:
Lead Regional Director, U.S. Fish and Wildlife Service

Approve Aaron L Valt Date 11-16-14

APPENDIX A
Summary of peer review for the 5-year review of Rough-leaved Loosestrife (*Lysimachia asperulaefolia*)

A. Peer Review Method:
In June 2009, a draft copy of the five year review was emailed to botanists with the NC Plant Conservation Program (Laura Gadd Robinson), NC Natural Heritage Program (Misty Buchanan), the NC Botanical Garden (Michael Kunz), Fort Jackson Military Base (Mark Dutton), Fort Bragg Army Base (Janet Gray) and the SC Heritage Trust Program (Bert Pittman). Reviewers provided comments by email, modifications to the original document and/or in "track changes." All of the peer reviewers know the species and are familiar with the habitats where the species occurs and the threats to its long term survival.

B. Peer Review Charge:
Peer reviewers were asked to provide written comments on the information presented in our analysis of the status of *Lysimachia asperulaefolia* and to provide comments on the validity of the data. Peer reviewers were not asked to provide recommendations on the legal status of the species.

C. Summary of Peer Review Comments/Report:
The peer reviewer from the NCNHP provided additional information on a population that was discovered in 1991, but only reported to the NCNHP in 2008. She provided updates to Appendix D as well as useful suggestions with regards to comparing populations rather than sub-populations and also provided helpful information on low seed production observed in this species.

The peer reviewer from the SC Heritage Trust Program provided additional information on surveys for this species in areas of suitable habitat in that state.

The reviewer from the NC Botanical Garden provided additional information on experimental translocation projects in which they are involved.

The reviewer from Fort Bragg provided information about specific population monitoring on their property. All peer reviewers suggested some changes in wording throughout that greatly improved the quality of the document.

D. Response to Peer Review:
The author accepted all comments provided by the reviewers and/or attempted to incorporate them into the document where appropriate.

APPENDIX B
Lysimachia asperulaefolia Monitoring Protocols

TO: Land managers and botanists interested in rough-leaved loosestrife monitoring
FROM: Monitoring Protocol Committee
DATE: April 10, 2000
FROM: Moni Bates, NC Plant Conservation Program
8023 Witty Road
Summerfield, NC 27358
336-643-3344
email: rjcbates@mindspring.com

Below is the revised rough-leaved loosestrife monitoring protocol based on comments submitted by land managers. The end of April I will send out packets to the land managers listed on page seven. The packets will include the monitoring protocol, monitoring forms, and element occurrence records from the Natural Heritage Program. From these records and the suggested table on page seven we will decide which and how many populations to monitor. Below are estimates for time required to conduct each level of monitoring. Thanks for your help in developing these protocols. We are also working with the U.S. Fish and Wildlife Service about incorporating the monitoring protocols into the Recovery Plan.

Time Estimates:
Level One: 15-30 minutes with one person (Fill out NC NHP Rare Plant Survey Form)
Level Two: 2-4 hours with two people (Direct counts in populations of less than 250 stems)
Level Three: 5-8 hours with two people (In populations of over 250, dependent on population size, number of plots, and density of stems within the plots)

Monitoring Protocols
for
Lysimachia asperulifolia
(Rough-leaved loosestrife)

Goal: Maintain stable and expanding populations of Rough-leaved loosestrife across its range to achieve recovery of the species. The goal is to conduct some form of management that improves the habitat for Rough-leaved loosestrife and to monitor the consequences of this management. The primary management tool is fire. Monitoring will then take place to assess the trends in abundance in response to the management regime.

Objective: To implement a consistent monitoring protocol for Rough-leaved loosestrife for identified population centers to determine stability of populations. Population centers are on Federal, State and private lands, as specified in the Rough-leaved loosestrife Recovery Plan (USFWS 1995).

Approach: Select one of three levels of monitoring for populations on public and private lands across the species' range. Populations should be selected to allow for comparisons of the species' variability across its range.

Level One Monitoring: Qualitative

Objective 1. Conduct a survey to locate occurrences of Rough-leaved loosestrife. Fill out the NC NHP Endangered and Rare Plant Field Survey Form (attached) and submit to the North Carolina Natural Heritage Program. Update the survey form every two years.

Objective 2. If possible, GPS sites and add coordinates to survey form.

Level Two Monitoring: Quantitative

Objective 1. In select populations of 250 or fewer stems, conduct a census that includes total number of stems; include total number of flowering and fruiting stems. If the land manager is unable to census during the flowering and fruiting season, then determine total number of stems only. Attempt to conduct an annual census because a minimum of ten years of data is required to perform a population viability analysis. It is possible to skip years; however, this delays data analysis beyond ten years.

Objective 2. If possible, GPS sites and add coordinates to survey form. Estimate the extent of aerial coverage or measure sides of populations. For example, population occupies an area bounded by x by x square meters.

Complete and return NC Plant Conservation Program (NC PCP) Monitoring Form.

Level Three Monitoring: Quantitative

Objective 1. In select populations of over 250 stems, count total number of stems and total number of flowering and fruiting stems for each randomly placed permanent plot on belt transects. If the land manager is unable to census during the flowering and fruiting season, then determine total number of stems only. As for level two, the goal is to perform a minimum of ten (not necessarily consecutive) annual censuses for each population. Map the approximate boundary of the population to derive population area.

Randomly place belt transects across the population running from the pocosin edge outward and into the savanna. Place enough plots to census 10% or more of the total population. Suggested plot size is 1/2 to 1 meter by 5 to 10 meters. During the first year of monitoring, check for consistency and determine amount of measurement error by conducting multiple counts in sequence (e.g., on the same day) for two or three plots per site. Repeat every two to three years.

If requested, a NC PCP botanist will meet with land managers the first year and help design and establish permanent plots. Complete and return NC Plant Conservation Program (NC PCP) Monitoring Form.

Data Collection and Analysis:

The NC PCP will send annual reminder notices to land managers to monitor their populations. **The NC PCP will collect and analyze data from Levels Two and Three, then share this information with the monitoring committee and land managers.**

Timeline:

May - July	Monitor and collect field data
September 1	Send data to NC PCP
December 1	NC PCP analyze data
January or February	Monitoring committee meet and send update to land managers

Status Survey:

Funding permitting, every ten years a State or Federal agency will coordinate a status survey that includes populations on public and private property.

Monitoring Committee:

Representatives from NCPCP, NCNHP, USFWS and land managers will review monitoring data and address the recovery progress. The monitoring committee will also prioritize research needs and encourage academic research.

Photopoint Monitoring (Optional):

Some land managers may wish to use photo documentation in certain populations. This is a simple means of documenting the landscape condition and shrub cover over several years. Considerations for photopoint monitoring are:

1. Establish and mark a permanent point

2. For archival purposes, use either black and white prints (film: Kodak T-max 100) or Kodachrome slides with E-13 processing
3. The vertical angle of the camera maintained at 90 degrees
4. Take the photograph with the sun behind or directly above
5. Record date, time, and name of photographer
6. Store prints and slides in dark, cool, low relative humidity location in a metal file or cabinet. Place slides in plastic holders.

North Carolina Plant Conservation Program
Monitoring Form for Levels Two and Three

Species Name: *Lysimachia asperulifolia* (Rough-leaved loosestrife)
Census Date:
Name of Land Manager or Agency:
Name of Person(s) Conducting Census:
Name of Population or Element Occurrence Number:
Management History:

Date of Last Burn: Month Year
Notes About Burn (very hot, crown fire; cool, ground fire, etc):

Previous Burn(s) (if possible, provide first year only):
Month Year
Month Year
Month Year

Additional management information (provide if possible):

Timber Data:

1. **Pines (include species, basal area, average dbh and number of stems/acre):**

2. **Hardwoods (average diameter breast height, number of stems/acre, height):**

Description of location of plow lines for fire breaks:

If present, evergreen shrub drain:
proximity of population to drain:
condition of the vegetation within the drain:
_____% switchcane _____% grasses _____% shrubs _____% trees
_____% canopy cover in pines _____% canopy cover in hardwoods

Description of other management practices:

Level Two Data:

Total Number of Stems: _____stems
Total Number of Budding/Flowering and/or Fruiting Stems:
_____budding ____flowering _____fruiting stems

Level Three:

Total Area of Population (square meters):

Area of Each Plot (square meters):

Sketch population showing position of transects and plots:

Level Three Data:

Transect #	Plot #	Total # of Stems	Total # of Flowering & Fruiting Stems

Return form to: N.C. Plant Conservation Program
Post Office Box 27647
Raleigh, NC 27611

Possible Populations for Different Levels of Monitoring by Agencies:

Holly Shelter Game Land (5 populations):

Select one or more populations at level two:	EO# 74 or 76
Select one or more populations at level three:	EO# 75, 77, or 12
Remaining populations at level one.	

Sandhill Game Land (4 populations):

Select one or more populations at level two:	EO# 06, 28, or 62
One population at level three:	EO# 14
Remaining populations at level one.	

Green Swamp - NC Nature Conservancy (5 populations):

Select one or more populations at level two:	EO# 72 or 73
Select one or more populations at level three:	EO# 10, 46, or 79
Remaining populations at level one.	

Camp Mackall (1 population):

One population at level two:	EO# 61

Sunny Point :

One population at level three:	EO# 13

Fort Bragg (26 populations):

Select one or more populations at level two.	EO# 15, 30, 51, 53, 55, 59, 60, 61, 64, 67, 68, 69, 70, 89
Select one or more populations at level three.	N/A
Remaining populations at level one.	EO# 21, 26, 40, 43, 52, 54, 58, 65 (Impact Area Populations)

Croatan National Forest (6 populations):

Select one or more populations at level two:	EO# 04, 23, 41, or 42
Select one or more populations at level three:	EO# 16, 23, 25, or 42
Remaining populations at level one.	

Camp Lejeune (8 populations):

Select one or more populations at level two:	EO# 49, 50, 71, 80, or 82
Select one or more populations at level three:	EO# 11, 24, or 81
Remaining populations at level one.	

Fort Jackson:

Continue current monitoring protocol which is equivalent to Level Three.

This table shows the number of monitored populations for each level, if each agency agrees to monitor the minimal number of populations proposed in the monitoring protocol.

Land Manager	Level 1	Level 2	Level 3
Holly Shelter Game Land	3	1	1
Sandhill Game Land	2	1	1
Nature Conservancy	3	1	1
Camp McKall	0	1	0
Sunny Point	0	0	1
Fort Bragg	9	14	0
Croatan Ntl Forest	4	1	1
Camp Lejeune	6	1	1
Fort Jackson	0	0	1 (their current protocol)
TOTALS	42	7	8

Level one is an update to NCNHP Endangered and Rare Plant Survey Form and is reported to NCNHP. Potentially, forty two populations would be updated every two years.

Levels two and three include census data using the NCPCP Monitoring Level form and are reported to the NCPCP. Potentially, 15 populations would be monitored on an annual basis.

North Carolina Natural Heritage Program - Endangered and Rare Plant Field Survey Form

Return form to: N.C. Natural Heritage Program, 1601 MSC, Raleigh, NC 27699-1601.

Species: Common name: Survey date:

EO Number (if updating existing EO): County: 7.5' Quad Map:

Coordinates (if known): Elevation:
If coordinates given, indicate coordinate system and datum (State Plane 1927 or 1983, UTM, etc):

Site Name (if this is within previously identified site):
Site location and directions: (attach copy of map with site marked or use back of form to draw a sketch of the site):

Number of individuals: Define individual (stem, clump, etc.):

Size of area in which population occurs:

Estimate whether the entire population was surveyed, or only a portion:

Estimated Population Viability (circle one): Excellent Good Fair Poor Unknown Failed to find
Population Viability Comments:

Phenology (include % or # in each stage): vegetative bud flower

Evidence of reproduction: fruit seedlings clonal/vegetative

Reproduction Comments:

Habitat (NC NHP natural community name and description, if known; include quality, soils, geology, etc.):

Associated species:

Area of apparently suitable habitat (suitable for, but not necessarily occupied by the species):

If the population is within a Right-of-Way, does suitable habitat exist outside Right-of-Way?

Light (examples: open, woodland, closed canopy, etc):

Other information:

Protection / management needs and opportunities:

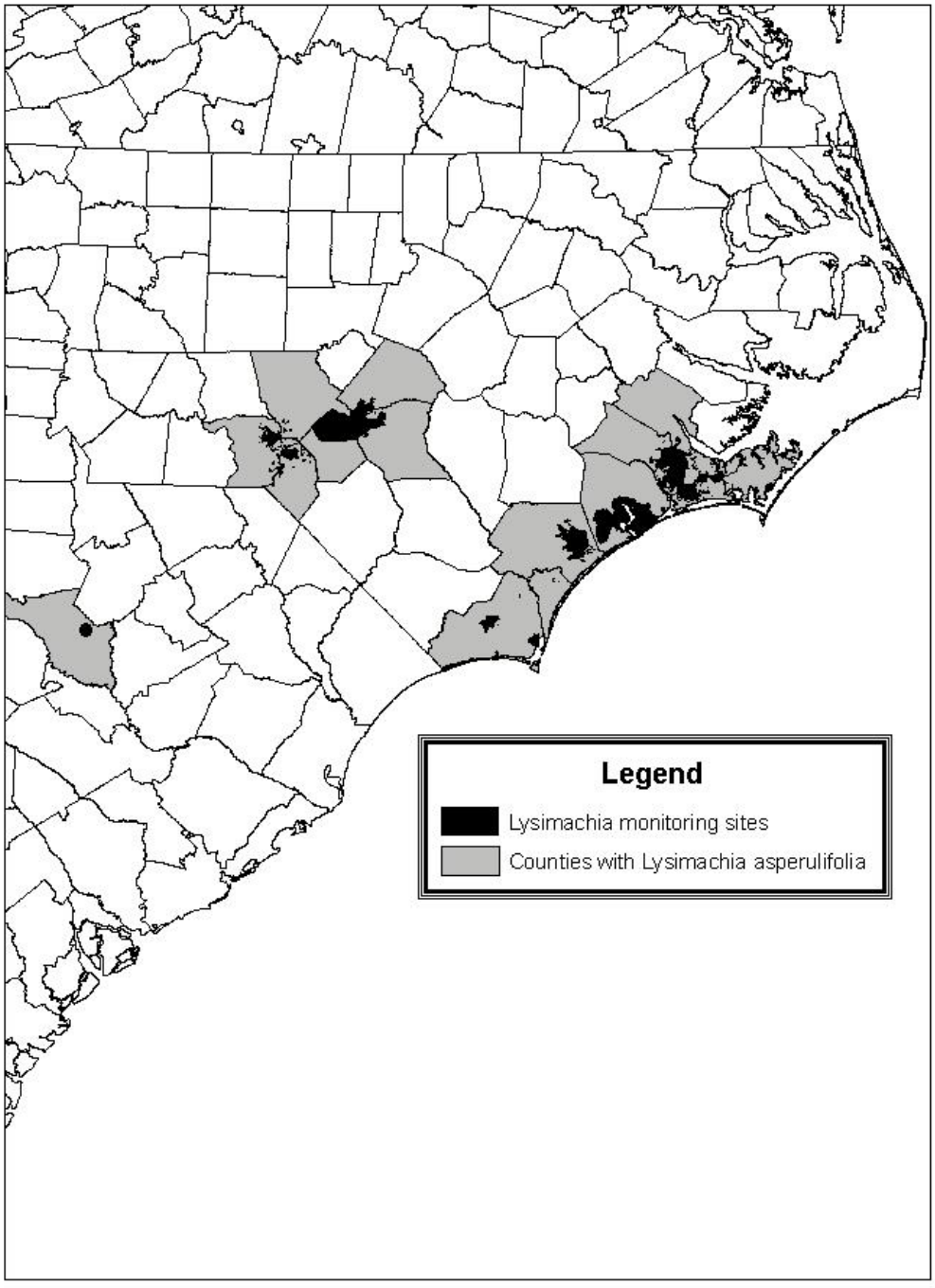
Landowner(s), if known:

Person making this report, Address, & Phone:

Other observers:

Specimens collected? Collection #: Repository:
(permits are required for federal or state listed species)

Draw sketch below or attach map.


Legend
Lysimachia monitoring sites
Counties with Lysimachia asperulifolia

APPENDIX C
Bibliography of documents mentioning *Lysimachia asperulaefolia*

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APPENDIX D
Summary of *Lysimachia asperulaefolia* populations
(EO# = Element Occurrence Number)

EO Number	County	Survey Site Name	Rank	Conser -vation Land	Last Observed Date	Ownership
NORTH CAROLINA						
1	Brunswick	Waccamaw Island Savanna	H	N	1981-05-19	
2	Pender	Holly Shelter Station [Not Mapped]	H	N	1954-06	
3	Bladen	Mill Pond Bay Natural Area	F	N	1986-06-24	
5	Pender	421 Sand Ridge: Jack Bay Powerline Corridor	B	N	1999-07-06	
7	Cumberland	6.8 Miles south of Fayetteville on NC 87	F	N	1957-08	
8	Cumberland	Bushy Lake	D	Y	2002-06-15	NCDPR
13	Brunswick	Military Ocean Terminal at Sunny Point	B?	Y	2013-05-29	MOTSU
14	Scotland	Sandhills Game Land: Crawford Lake	BC	Y	2012-07-26	NCWRC
18	Brunswick	NC-133 Loosestrife Site, North of Kendall Chapel	C	N	2006-06-07	NCDOT
19	Brunswick	Green Swamp #3	X?	N	1962-06	
22	Brunswick	Western Boiling Spring Lakes	A	Y	2012-06-01	BSL
31	Beaufort	South of Washington, Beaufort County	H	N	1938-06-10	
32	Columbus	Delco, NC	H	N	1938-08-29	
33	Pamlico	South of Grantsboro, NC 306	H	N	1948	
34	Pamlico	Pamlico Community College	F	N	1990-05-03	
35	various	Drowning Creek	H	N	1935-06	
36	Cumberland	East Mountain Road Powerline Seep	C	N	1999-05-24	
38	Cumberland	Manchester, Cumberland County	H	N	1902-06-25	
39	Pender	Burgaw	H	N	1879-08	
44	Hoke	Fort Bragg Juniper Creek Headwaters Natural Area: McKeithan Pond	BC	Y	1994-06-01	Fort Bragg
59	Hoke	Fort Bragg Nicholson Creek Powerline Plant Site	C	Y	2009	Fort Bragg
61	Scotland	Camp Mackall, Big Muddy Lake	D	Y	2009	Camp Mackall
62	Scotland	Sandhills Game Land, Beaver Dam Creek Swamp	X?	Y	2004-06-08	NCWRC
64	Hoke	Fort Bragg, Field Branch	D	Y	2009	Fort Bragg
68	Hoke	Fort Bragg, James Creek	F	Y	2003	Fort Bragg
69	Hoke	Fort Bragg, Flat Creek	D	Y	2009	Fort Bragg
71	Onslow	Western Camp Lejeune Macrosite, Padgett Swamp Road Natural Area	D	Y	2002	Camp Lejeune
77	Pender	Holly Shelter Game Land, Lodge Road	C	Y	2009-07-13	NCWRC
78	Beaufort	Prescott Ridge/ Suffolk Scarp Bogs Site	F	N	1993	
83	Brunswick	Boiling Spring Lakes Wetland Complex	BC	Y	2006-06	BSL
84	New Hanover	West of US-17, Southwest of Scott Hill and North of Porter	F	N	1996-07-18	

85	New Hanover	West of US-17, South of I-40 Connector, Head of Island Creek.	C	N	2003-02-21	
86	Cumberland	Hope Mills Powerline Rare Plant Site	D	N	2011-05-31	
88	Onslow	Batchelor Road Flatwoods: North-south running powerline corridor	D	N	2000-05-30	
89	Harnett	Fort Bragg, NC-87 Powerlines	C	Y	2009	Fort Bragg
90	Carteret	Croatan NF Megasite, West of Broad Creek: Pettiford Creek	A	Y	2011-10-05	Croatan NF
92	Richmond	Marks Creek Powerline	B	N	2005-07-12	
93	Cumberland	Canady Street Powerline	D	N	2008-07-15	
94	Brunswick	East of Malmo, between Alligator Branch and US-74/76	C	N	2002-08-02	
95	Pender	Powerline Southwest of Haws Run	BC	Y	2002-06-18	DPR
96	Pender	Bear Garden	D	Y	2012-06-19	WRC
100	New Hanover	Murrayville (NCDOT) Mitigation Site	Cr	Y	2005	NCDOT
105	Carteret	Croatan NF Megasite, Hibbs Road Area	A	Y	2011-05-20	Croatan NF
105.004	Carteret	Croatan NF Megasite, Hibbs Road Area: Near Camp Sam Hatcher	D	Y	2011-05-20	Croatan NF
105.023	Carteret	Croatan NF Megasite, Hibbs Road Area: FSR 154, 0.3 Miles West of Hibbs Road	A	Y	2009	Croatan NF
105.025	Carteret	Croatan NF Megasite, Hibbs Road Area: FSR 154, Headwaters of Blakes Branch	D	Y	2008-06-07	Croatan NF
105.041	Carteret	Croatan NF Megasite, Hibbs Road Area: East of Broad Creek, Nine Foot Road/Broad Cr. Pinewoods	C?	Y	2013-10-05	Croatan NF
105.042	Carteret	Croatan NF Megasite, Hibbs Road Area: Newport Triangle	C?	Y	1991-10-17	Croatan NF
105.153	Carteret	Croatan NF Megasite, Hibbs Road Area: Training Center Complex	F	Y	1989-06-25	Croatan NF
105.154	Carteret	Croatan NF Megasite, Hibbs Road Area: Across from Landfill Entrance	F	Y	1989-06-25	Croatan NF
105.155	Carteret	Croatan NF Megasite, Hibbs Road Area: East of Hibbs Road and West of US-70	F	Y	1989-06-25	Croatan NF
105.156	Carteret	Croatan NF Megasite, Hibbs Road Area: Along Hibbs Road	D	Y	1989-07-07	Croatan NF
105.157	Carteret	Croatan NF Megasite, Hibbs Road Area: FSR 154, 0.45 Miles West of Hibbs Road	F	Y	1989-08-20	Croatan NF
105.158	Carteret	Croatan NF Megasite, Hibbs Road Area: South of Roberts Road	D	Y	1989-08-26	Croatan NF
105.159	Carteret	Croatan NF Megasite, Hibbs Road Area: FSR 154, 0.6 miles West of Hibbs Road	D	Y	1989-06-16	Croatan NF
105.160	Carteret	Croatan NF Megasite, Hibbs Road Area: FSR 154, 0.7 miles West of Hibbs Road	D	Y	1989-08-20	Croatan NF
105.161	Carteret	Croatan NF Megasite, Hibbs Road Area: FSR 154, 0.8 miles West of Hibbs Road	B	Y	2011-05-20	Croatan NF

105.162	Carteret	Croatan NF Megasite, Hibbs Road Area: FSR 154, 1.3 miles West of Hibbs Road	C	Y	2009	Croatan NF
105.163	Carteret	Croatan NF Megasite, Hibbs Road Area: FSR 154, 1.10-1.15 miles West of Hibbs Road	C	Y	2011-05-20	Croatan NF
105.164	Carteret	Croatan NF Megasite, Hibbs Road Area: FSR 154, 2.4 & 2.5 Miles East of Nine Foot Road	F	Y	1997-06	Croatan NF
105.165	Carteret	Croatan NF Megasite, Hibbs Road Area: East side of Landfill Road	D	Y	1989-07-08	Croatan NF
105.166	Carteret	Croatan NF Megasite, Hibbs Road Area: West side of Landfill Road	D	Y	1989-07-08	Croatan NF
105.167	Carteret	Croatan NF Megasite, Hibbs Road Area: West side of Landfill Road	D	Y	1991-10-29	Croatan NF
105.168	Carteret	Croatan NF Megasite, Hibbs Road Area: West side of Landfill Road	D	Y	1991-10-29	Croatan NF
105.169	Carteret	Croatan NF Megasite, Hibbs Road Area: West side of Landfill Road	C	Y	1991-10-29	Croatan NF
105.170	Carteret	Croatan NF Megasite, Hibbs Road Area: West side of Landfill Road	D	Y	1991-10-29	Croatan NF
105.171	Carteret	Croatan NF Megasite, Hibbs Road Area: West of Landfill	C	Y	1991-06	Croatan NF
105.172	Carteret	Croatan NF Megasite, Hibbs Road Area: West of Landfill	D	Y	1991-06	Croatan NF
105.173	Carteret	Croatan NF Megasite, Hibbs Road Area: West of Landfill	D	Y	1991-06	Croatan NF
105.174	Carteret	Croatan NF Megasite, Hibbs Road Area: West of Landfill	D	Y	1991-06	Croatan NF
105.175	Carteret	Croatan NF Megasite, Hibbs Road Area: FSR 154, 1.44 & 1.47 Miles East of Nine Foot Road	D	Y	2011-05-20	Croatan NF
105.176	Carteret	Croatan NF Megasite, Hibbs Road Area: FSR 154, 1.15 Miles East of Nine Foot Road	D	Y	1989-06-10	Croatan NF
105.177	Carteret	Croatan NF Megasite, Hibbs Road Area: FSR 154, 1.15 Miles East of Nine Foot Road	BC	Y	1989-06-10	Croatan NF
105.178	Carteret	Croatan NF Megasite, Hibbs Road Area: FSR 154, 0.9 Miles East of Nine Foot Road	F	Y	1989-06-17	Croatan NF
105.179	Carteret	Croatan NF Megasite, Hibbs Road Area: FSR 154, 0.85 East of Nine Foot Road	D	Y	2011-05-20	Croatan NF
105.180	Carteret	Croatan NF Megasite, Hibbs Road Area: FSR 154, 0.60 East of Nine Foot Road	F	Y	1989-06-16	Croatan NF
105.181	Carteret	Croatan NF Megasite, Hibbs Road Area: FSR 154, 0.6 Miles East of Nine Foot Road	A	Y	2011-05-20	Croatan NF
105.182	Carteret	Croatan NF Megasite, Hibbs Road Area: FSR 154, 0.90 Miles West of Hibbs Road	B	Y	2010	Croatan NF
105.183	Carteret	Croatan NF Megasite, Hibbs Road Area: FSR 154, 1.05 miles West of Hibbs Road	D	Y	1989-08-19	Croatan NF
105.184	Carteret	Hibbs Road Area: FSR 154, 1.05 miles West of Hibbs Road	B	Y	2011-10-05	Croatan NF

105.185	Carteret	Croatan NF Megasite, Hibbs Road Area: West side of Landfill Road	B	Y	2007-05-17	Croatan NF
105.186	Carteret	Croatan NF Megasite, Hibbs Road Area: West Side of Landfill Road	B	Y	2007-05-17	Croatan NF
105.187	Carteret	Croatan NF Megasite, Hibbs Road Area: FSR 154, 0.6 Miles East of Nine Foot Road	D	Y	2003-09-30	Croatan NF
105.188	Carteret	Croatan NF Megasite, Hibbs Road Area: Along Hibbs Road	C	Y	2007-05-17	Croatan NF
105.193	Carteret	Croatan NF Megasite, Hibbs Road Area: Stand 12 - Sites HR1/HR4	D	Y	2010-05-13	Croatan NF
105.194	Carteret	Croatan NF Megasite, Hibbs Road Area: Stand 12 - Site HR08	D	Y	2010-05-13	Croatan NF
105.195	Carteret	Croatan NF Megasite, Hibbs Road Area: Stand 10 - Site HR09	D	Y	2010-06-17	Croatan NF
105.196	Carteret	Croatan NF Megasite, Hibbs Road Area: Stand 10 - Site HR10	C	Y	2010-06-17	Croatan NF
105.197	Carteret	Croatan NF Megasite, Hibbs Road Area: Stand 10 - Site HR11	D	Y	2010-06-17	Croatan NF
105.198	Carteret	Croatan NF Megasite, Hibbs Road Area: Stand 10 - Site HR12	D	Y	2010-06-17	Croatan NF
105.199	Carteret	Croatan NF Megasite, Hibbs Road Area: Stand 10 - Site HR13	C	Y	2010-06-17	Croatan NF
105.200	Carteret	Croatan NF Megasite, Hibbs Road Area: Stand 10 - HR14	D	Y	2010-06-17	Croatan NF
105.202	Carteret	Croatan NF Megasite, Hibbs Road Area: Stand 10 - Site HR15	D	Y	2010-06-17	Croatan NF
105.203	Carteret	Croatan NF Megasite, Hibbs Road Area: Stand 10 - HR16	D	Y	2010-05-15	Croatan NF
105.204	Carteret	Croatan NF Megasite, Hibbs Road Area: Stand 12 - Site HR17	D	Y	2010-05-16	Croatan NF
114	Bladen	Rosindale Longleaf Pine Forest	A	N	2004-11-07	
123	Onslow	Western Camp Lejeune Macrosite	E	Y	2002	Camp Lejeune
129	Brunswick	Brunswick County; 0.5 mile north of Coolvale	A?	N	2012-SUM	
131	Onslow	Camp Lejeune	A	Y	2008-06-11	Camp Lejeune
131.024	Onslow	Camp Lejeune: G-10 Impact Area, Training Area GF	C	Y	2011-05-23	Camp Lejeune
131.049	Onslow	Camp Lejeune: G-10 Impact Area	D	Y	1999	Camp Lejeune
131.050	Onslow	Camp Lejeune: Camp Lejeune Center Macrosite, Training Area HB	C	Y	2010	Camp Lejeune
131.080	Onslow	Camp Lejeune: Training Area HE-11	C	Y	2009	Camp Lejeune
131.081	Onslow	Camp Lejeune: HB-7	A	Y	2010	Camp Lejeune
131.082	Onslow	Camp Lejeune: IA-4	BC	Y	2010	Camp Lejeune
131.124	Onslow	Camp Lejeune: Dove Road Pocosin	E	Y	2009	Camp Lejeune

131.125	Onslow	Camp Lejeune: Longleaf Pine Ridge	B	Y	2011-05-24	Camp Lejeune
131.126	Onslow	Camp Lejeune: G-10 Impact Area, Group M29	E	Y	2007	Camp Lejeune
131.127	Onslow	Camp Lejeune: G-10 Impact Area, Groups J9 and J10	E	Y	1999	Camp Lejeune
131.128	Onslow	Camp Lejeune: Longleaf Pine Ridge	E	Y	2009	Camp Lejeune
132	Onslow	Great Sandy Run Pocosin Area	A	Y	2008-06-23	Camp Lejeune
132.011	Onslow	Great Sandy Run Pocosin Area: US-17	D?	Y	1987-07-16	Camp Lejeune
132.115	Onslow	Great Sandy Run Pocosin Area: Camp Lejeune South Bay Road NA	B	Y	2011-07-05	Camp Lejeune
132.116	Onslow	Great Sandy Run Pocosin Area: Groups Q12 and Q13	BC	Y	2010	Camp Lejeune
132.117	Onslow	Great Sandy Run Pocosin Area: Group P14	A	Y	2010	Camp Lejeune
132.118	Onslow	Great Sandy Run Pocosin Area: US-17 Powerline near Joe's Trail - Groups H16 and H17	BD	Y	2010	Camp Lejeune
132.119	Onslow	Great Sandy Run Pocosin Area: US-17 Powerline near South Bay Access Road	C	Y	2003	Camp Lejeune
132.120	Onslow	Great Sandy Run Pocosin Area: US-17 Powerline North of South Bay Access Road - Group H20	BC	Y	2011-07-06	Camp Lejeune
132.121	Onslow	Great Sandy Run Pocosin Area: US-17 Powerline North	D	Y	2003	Camp Lejeune
132.134	Onslow	Great Sandy Run Pocosin Area: US-17 Powerline, Group G15	D	Y	2003	Camp Lejeune
132.151	Onslow	Great Sandy Run Pocosin Area: Group W1	E	Y	2004	Camp Lejeune
133	Onslow	Camp Lejeune/Holly Shelter Megasite, Group R26	E	Y	2009	Camp Lejeune
138	Craven	Croatan National Forest, South of West Prong Brice Creek and North of Catfish Lake Road	E	Y	1991-06-11	Croatan NF
139	Carteret	Croatan NF Megasite, West of Broad Creek	A	Y	2010-05-20	Croatan NF
139.016	Carteret	Croatan NF Megasite, West of Broad Creek: Pringle Road Bay Rims	F	Y	1985-06-12	Croatan NF
139.099	Carteret	Croatan NF Megasite, West of Broad Creek: Pettiford Creek Open Flatwoods	B	Y	2011-05-20	Croatan NF
139.101	Carteret	Croatan NF Megasite, West of Broad Creek: Pettiford Creek Game Land	D	Y	2004-05-26	Croatan NF
139.102	Carteret	Croatan NF Megasite, West of Broad Creek: Pettiford Creek Gameland	CD	Y	2004-06-14	Croatan NF
139.103	Carteret	Croatan NF Megasite, West of Broad Creek: Pettiford Creek State Forest	C	Y	2004-06-14	Croatan NF
139.106	Carteret	Croatan NF Megasite, West of Broad Creek: Pringle Road Bay Rims	D	Y	2011-05-20	Croatan NF
139.108	Carteret	Croatan NF Megasite, West of Broad Creek: Pringle Road Bay Rims	B	Y	2004-05-04	Croatan NF

139.110	Carteret	Croatan NF Megasite, West of Broad Creek: Pringle Road Bay Rims	D	Y	2007-05-18	Croatan NF
139.112	Carteret	Croatan NF Megasite, West of Broad Creek: Pringle Road Bay Rims	A?	Y	2010-SUM	Croatan NF
140	Pender	Holly Shelter Game Land, Southwest Ridge Area	A	Y	2010-07-20	NCWRC
140.012	Pender	Holly Shelter Game Land, Southwest Ridge Area: Southwest Ridge Savanna	A	Y	2000-06-28	NCWRC
140.074	Pender	Holly Shelter Game Land, Southwest Ridge Area: Lodge Road	D	Y	2009-07-13	NCWRC
140.076	Pender	Holly Shelter Game Land, Southwest Ridge Area: T Island Savannas	BD	Y	2010-07-20	NCWRC
140.209	Pender	Holly Shelter Game Land, Southwest Ridge Area: Lodge Road Powerline	A	Y	2009-07-13	NCWRC
141	Pender	Shaken Creek Savanna/Shelter Swamp Creek Flatwoods	AB	Y	2002-06-20	TNC
141.087	Pender	Shaken Creek Savanna/Shelter Swamp Creek Flatwoods: Half Moon Road	A	Y	1999-06-14	TNC
141.091	Pender	Shaken Creek Savanna/Shelter Swamp Creek Flatwoods: Indian Grave Ridge	C	Y	2002-06-20	TNC
142	Brunswick	Eastern Boiling Spring Lakes	BC	Y	2000-06-07	BSL
142.009	Brunswick	Eastern Boiling Spring Lakes: Boiling Spring Lakes	H	Y	1966-07	BSL
142.017	Brunswick	Eastern Boiling Spring Lakes: Orton Powerline Loosestrife Site	C	Y	1999-05-25	BSL
142.020	Brunswick	Eastern Boiling Spring Lakes: NC-133 North of Fifty Lakes Drive	D	Y	2000-06-07	BSL
143	Brunswick	Green Swamp	A	Y	2012-08-12	TNC
143.010	Brunswick	Green Swamp: Shoestring, String Bean, and Bean Patch	A	Y	2012-06-22	TNC
143.046	Brunswick	Green Swamp: Little Island and Firelane Savannas	D?	Y	2012-08-12	TNC
143.072	Brunswick	Green Swamp, Big Island Savanna	D	Y	1993	TNC
143.073	Brunswick	Green Swamp, Big Cow Island	C	Y	1994-06-26	TNC
143.079	Brunswick	Green Swamp, The Soups	A	Y	1992-05-04	TNC
143.135	Brunswick	Green Swamp, Big Island Savanna and ecotone northeast of borrow pit	BC	Y	2008-06-12	TNC
143.136	Brunswick	Green Swamp, Big Island, Borrow Pit Pond/Boardwalk Area	C	Y	2012-06-22	TNC
143.137	Brunswick	Green Swamp, Calf Island/Near Deer Island	C	Y	2005-06-12	TNC
144	Cumberland	Ft. Bragg Spring Lake Macrosite	D	Y	2003	Fort Bragg
144.053	Cumberland	Ft. Bragg Spring Lake Macrosite, Texas Pond Tributary	D	Y	2009	Fort Bragg
144.055	Cumberland	Ft. Bragg Spring Lake Macrosite, Nea Bog West	D	Y	2009	Fort Bragg
145	Cumberland	Central Fort Bragg, Near the Little River	B	Y	2003	Fort Bragg
145.051	Cumberland	Central Fort Bragg, Near the Little River: Little River	X	Y	1992-08-11	Fort Bragg
145.054	Cumberland	Central Fort Bragg, Near the Little River: Cypress Creek	F	Y	1991-10-21	Fort Bragg

145.060	Cumberland	Central Fort Bragg, Near the Little River: Unnamed Creek/ Little River	F	Y	2005	Fort Bragg
145.065	Cumberland	Central Fort Bragg, Near the Little River: Cypress Creek	F	Y	1992-08-23	Fort Bragg
145.070	Cumberland	Central Fort Bragg, Near the Little River: Hector Creek / Lake Lindsay	C	Y	2009	Fort Bragg
145.130	Cumberland	Central Fort Bragg, Near the Little River: NC SOTF Compound	C	Y	1994-05-05	Fort Bragg
146	Cumberland, Hoke	Fort Bragg, Little Rockfish Creek Natural Area	A	Y	1993-08-31	Fort Bragg
146.043	Cumberland, Hoke	Fort Bragg Little Rockfish Creek Natural Area	A	Y	2005	Fort Bragg
146.052	Cumberland	Fort Bragg Little Rockfish Creek Natural Area	B	Y	2005	Fort Bragg
146.058	Cumberland, Hoke	Fort Bragg, MacRidge Impact/Danger Areas	A	Y	2009	Fort Bragg
148	Hoke	Fort Bragg, Little Rockfish Creek and Tributaries:	A	Y	2003	Fort Bragg
148.015	Hoke	Fort Bragg, Little Rockfish Creek and Tributaries: Central Rockfish Creek Natural Area	D	Y	2003	Fort Bragg
148.021	Hoke	Fort Bragg, Little Rockfish Creek and Tributaries: Calf Branch Natural Area	A	Y	1992-10-10	Fort Bragg
148.030	Hoke	Fort Bragg, Little Rockfish Creek and Tributaries: Gum Branch Natural Area	D	Y	2003	Fort Bragg
148.057	Hoke	Fort Bragg, Little Rockfish Creek and Tributaries: Wolf Pit Creek Natural Area	F	Y	2006	Fort Bragg
148.063	Hoke	Fort Bragg, Little Rockfish Creek and Tributaries: Piney Bottom Creek Natural Area	BD	Y	2009	Fort Bragg
148.066	Hoke	Fort Bragg, Little Rockfish Creek and Tributaries: Piney Bottom Creek Natural Area	B	Y	1992-08-08	Fort Bragg
148.067	Hoke	Fort Bragg, Little Rockfish Creek and Tributaries: Southern Rockfish Creek Natural Area	D	Y	2009	Fort Bragg
149	Scotland	Sandhills Game Land, Near Cameon Lake	D	Y	2004-06-08	NCWRC
149.006	Scotland	Sandhills Game Land, Near Cameron Lake, Creek and Corridor below Kinney Cameron Lake	D	Y	2010-07-08	NCWRC
149.028	Scotland	Sandhills Game Land, Near Cameon Lake, Kinney Cameron Lake	X	Y	2000-06-06	NCWRC
152	Onslow	West of Great Sandy Run Pocosin	E	Y	2004	Camp Lejeune
152.122	Onslow	West of Great Sandy Run Pocosin: Group U25	E	Y	2002	Camp Lejeune
152.150	Onslow	West of Great Sandy Run Pocosin: Group V1	E	Y	2004	Camp Lejeune
189	Cumberland	Fort Bragg, Bones Creek	A	Y	2000	Fort Bragg
189.026	Cumberland	Fort Bragg, Bones Creek - North Occurrence	F	Y	1990-05-29	Fort Bragg
189.040	Cumberland	Fort Bragg, Bones Creek - Southern Occurrence	A	Y	2009	Fort Bragg
190	Brunswick	Boiling Spring Lakes Wetland Complex - Corbett Tract	D?	Y	2009-08-19	BSL
192	Hoke	Fort Bragg Puppy Creek Headwaters	A	Y	2010	Fort Bragg

192.045	Hoke	Fort Bragg, Coleman Imact Area/Range 63	A	Y	1994-06-02	Fort Bragg
192.191	Hoke	Fort Bragg Puppy Creek Headwaters	E	Y	2010	Fort Bragg
205	Brunswick	Boiling Spring Lakes, W. Boiling Spring Lakes Road	A	Y	2011-06-12	BSL
206	Brunswick	Boiling Spring Lakes: west of Craven Road	BC	Y	2011-06-13	BSL
207	Brunswick	Funston Bays: northeast of Pretty Pond	A	Y	2011-06-18	Croatan NF
208	Onslow	Sandy Run Swamp Powerline Savanna	X?	Y	2011-06-01	NCDPR
210	Brunswick	Boiling Spring Lakes, Honeysuckle Road	D	Y	2012-02-04	BSL
211	Onslow	Horse Swamp Savannas and Woodlands	D	N	2012-09-13	
213	Pender	Holly Shelter Game Land, East Tram Savannas	B?	Y	2010-07-20	NCWRC
213.075	Pender	Holly Shelter Game Land, East Tram Savannas (Monitoring Site)	C	Y	2010-07-20	NCWRC
213.212	Pender	Holly Shelter Game Land, East Tram Savannas (Experimental Transplant)	Bi	Y	2006-06-07	NCWRC
SOUTH CAROLINA						
1	Darlington	unnamed site	H	N	1857-06-01	Fort Jackson
2	Richmond	Fort Jackson	H	Y	1800	Fort Jackson
3	Richmond	Fort Jackson	AB	Y	1992-05-31	Fort Jackson
4	Richmond	Fort Jackson	AC	Y	1992-05-31	Fort Jackson

Definitions for ownership:

BSL – Boiling Springs Lakes Preserve jointly owned by The Nature Conservancy and NC Plant Conservation Program
Croatan NF – Croatan National Forest, U.S. Forest Service
Fort Jackson – Department of Defense
Camp Lejeune – Department of Defense
Camp Mackall – Department of Defense
Fort Bragg – Department of Defense
Military Ocean Terminal at Sunny Point (MOTSU) – Department of Defense
NCWRC – NC Wildlife Resources Commission
NCDOT – NC Department of Transportation
NCDPR – NC Division of Parks and Recreation
TNC – The Nature Conservancy

Definitions for EO Ranks following NCNHP methodology.

A - Excellent estimated viability
A? - Possibly excellent estimated viability
AB - Excellent or good estimated viability
AC - Excellent, good, or fair estimated viability
B - Good estimated viability
B? - Possibly good estimated viability
BC - Good or fair estimated viability
BD - Good, fair, or poor estimated viability
C - Fair estimated viability
C? - Possibly fair estimated viability
CD - Fair or poor estimated viability
D - Poor estimated viability
D? - Possibly poor estimated viability
E - Verified extant (viability not assessed)
F - Failed to find
F? - Possibly failed to find
H - Historical
H? - Possibly historical
X - Extirpated
X? - Possibly extirpated
U - Unrankable
NR - Not ranked