Management Guidelines for Species at Risk on Department of Defense Installations

DoD Legacy Project #03-154

Provided by NatureServe
to the U.S. Fish and Wildlife Service

May 2006

NatureServe

NatureServe is a non-profit organization dedicated to providing the scientific knowledge that forms the basis for effective conservation.

NatureServe Project Contact:

Nancy Benton
Project Manager
NatureServe
1101 Wilson Blvd., 15th Floor
Arlington, VA 22209
Tel: 703-908-1886
Fax: 703-908-1917
nancy_benton@natureserve.org

U.S. Fish and Wildlife Service Project Contact:

Lewis Gorman
FWS-DOD Liaison
U.S. Fish and Wildlife Service
4401 N. Fairfax Drive
Arlington, VA 22203
Tel: 703-358-1911
Fax: 703-358-1827
Lewis_Gorman@fws.gov

Front cover photos:
Left: Coastal goldenrod (*Solidago villosicarpa*) by Dale Suiter, U.S. Fish & Wildlife Service.
Right: Island fox (*Urocyon littoralis*).
Top center: Florida bog frog (*Rana okaloosae*) by David Printiss.
Bottom center: Round leaf four-o'clock (*Oxybaphus rotundifolius*) by Susan Spackman Panjabi, Colorado Natural Heritage Program.

NatureServe
1101 Wilson Boulevard, 15th Floor
Arlington, VA 22209
703-908-1800
www.natureserve.org

EXECUTIVE SUMMARY

Department of Defense lands play an essential role in maintaining homeland security, and are also important for safeguarding the nation's natural heritage. The 25 million acres managed by the Department of Defense (DoD) support more federally listed species than any other major federal agency, and harbor more imperiled species than even national parks and national wildlife refuges. Yet DoD installations are often islands of biodiversity within increasingly developed landscapes, which raises difficult natural resource management issues. Managing DoD lands in a way that supports military readiness and sustains ecological integrity requires an understanding of the species and ecosystems found on and around these bases.

Beginning in 2003, NatureServe and the U.S. Fish and Wildlife Service cooperated to analyze patterns of species at risk found on DoD installations. The objective of part I of the project was to assist the military in focusing conservation efforts on high-priority installations and towards high-priority species at risk that may warrant federal listing if population declines occur or continue. For that study, we defined species at risk on DoD installations to be: (1) plant and animal species that are not yet federally listed as threatened or endangered under the Endangered Species Act, but that are either designated as candidates for listing or are regarded by NatureServe as critically imperiled or imperiled throughout their range **and** (2) with populations on or near DOD installations.

In part II of the project, begun in 2004, detailed management guidelines were developed for key species at four DoD installations, with scientists from state natural heritage programs working cooperatively with biologists and natural resources managers from the U.S. Fish and Wildlife Service and each DoD installation. The species and associated pilot locations were:

- **Army:** Round leaf four o'clock *(Mirabilis rotundifolia)*, found on Fort Carson and Piñon Canyon Maneuver Site in Colorado.
- **Navy:** Island fox *(Urocyon littoralis)*, found on San Clemente Island Naval Reserve and San Nicolas Island in California.
- **Marines:** Coastal goldenrod *(Solidago villosicarpa)*, found on Camp Lejeune in North Carolina.
- **Air Force:** Florida bog frog *(Rana okaloosae)*, found on Eglin Air Force Base in Florida.

The results of part II are presented here, with a management guidelines document provided for each of the four species. By integrating these guidelines into Integrated Natural Resources Management Plans and implementing them effectively, DoD natural resources managers can help ensure that populations of these species at risk will be maintained over the long term.

Proactive conservation of imperiled species and their habitats on and around DoD installations can help preclude the need for federal listing, reduce recovery costs, and protect significant biological diversity, while enabling the services to continue providing high-quality military training. The species management guidelines developed not only can assist DoD resources managers, but will be valuable as well to other public land managers and private landowners facing similar issues.

Detailed results of the study with accompanying maps are available on the NatureServe website at www.natureserve.org/prodServices/speciesatRiskdod.jsp.

Master Table of Contents

Executive Summary ..... page 3 of PDF file

Coastal Goldenrod Management Guidelines ..... pages 5-30 of PDF file

Round Leaf Four O'Clock Management Guidelines ..... pages 32-64 of PDF file

Island Fox Management Guidelines..... pages 66-96 of PDF file

Florida Bog Frog Management Guidelines ..... pages 98-164 of PDF file

Note: Individual executive summaries and tables of contents for each of the four species management guidelines are provided at the start of each document.

Coastal Goldenrod

Management Guidelines for Species at Risk on Department of Defense Installations

NatureServe

North Carolina Natural Heritage Program
Science Guiding Conservation

NatureServe is a non-profit organization that provides the scientific basis for effective conservation.

Citation:
LeBlond, R. and M. Franklin. 2004. *Coastal Goldenrod: Management Guidelines for Species at Risk on Department of Defense Installations.* NatureServe, Arlington, Virginia.

This work was made possible with funding from the U.S. Department of Defense and the U.S. Fish and Wildlife Service.

Front cover photo: Coastal goldenrod (*Solidago villosicarpa*) by Dale Suiter, U.S. Fish & Wildlife Service.

NatureServe
1101 Wilson Boulevard, 15th Floor
Arlington, VA 22209
703-908-1800
www.natureserve.org

North Carolina Natural Heritage Program
North Carolina Dept. of Environment and Natural Resources
Office of Conservation and Community Affairs
1601 MSC
Raleigh, NC 27699
919-733-4181
www.ncsparks.net/nhp

COASTAL GOLDENROD

MANAGEMENT GUIDELINES FOR SPECIES AT RISK ON DEPARTMENT OF DEFENSE INSTALLATIONS

CAMP LEJEUNE MARINE CORPS BASE
NORTH CAROLINA

Richard LeBlond
Misty Franklin

April 2004

.

Table of Contents

1. Species Identifiers 1
2. Contacts 1
3. Species Range, Status, and Life History 2
4. Habitat Requirements 5
5. Threats to the Species 6
6. Regional Conservation Actions 7
7. DoD Conservation Actions 8
8. Measuring Effectiveness of Conservation Actions 10
9. Adaptive Management and Monitoring 11
10. Species Research 12
11. Information Management 12
12. Feasibility and Timetable 12
13. References Cited 14

Table 1. *Solidago villosicarpa* habitat associates 19

Appendix A: Habitat Requirements of *Solidago villosicarpa* 16
Appendix B: Photographs 22

1. Species Identifiers

Scientific name: *Solidago villosicarpa* (LeBlond 2000)

Common name: Coastal goldenrod, Carolina maritime goldenrod

Department of Defense Installation(s) where species occurs:
Camp Lejeune Marine Corps Base

2. Contacts

Department of Defense (DOD) Contacts:

John Townson
Head, Environmental Conservation Branch
Camp Lejeune Marine Corps Base
Building 58
Camp Lejeune, NC 28542
phone: 910-451-9384
fax: 910-451-1787
email: townsonjr@lejeune.usmc.mil

Craig Ten Brink
Wildlife Biologist, Threatened and Endangered Species Section
Camp Lejeune Marine Corps Base
Building 58
Camp Lejeune, NC 28542
phone: 910-451-7228
fax: 910-451-1787
email: tenbrinkce@lejeune.usmc.mil

U.S. Fish and Wildlife Service (USFWS) Contact:

Dale Suiter
Fish and Wildlife Biologist
Raleigh Ecological Services Office
U.S. Fish and Wildlife Service
P.O. Box 33726
Raleigh, NC 27636
phone: 919-856-4520 x 18
fax: 919-856-4556
email: Dale_Suiter@fws.gov

North Carolina Natural Heritage Program Contact (NCNHP):

Richard LeBlond, Primary Author
Botanist
North Carolina Natural Heritage Program
P.O. Box 787
Richlands, NC 28574
phone: 910-324-2671
fax: none
email: Richard.Leblond@ncmail.net

Misty Franklin
Botanist
North Carolina Natural Heritage Program
1615 Mail Service Center
Raleigh, NC 27699-1615
phone: 919-715-8700
fax: 919-715-3085
email: Misty.Franklin@ncmail.net

3. Species Range, Status, and Life History

Summarize the species status and historic and current range (include range maps, if available):

Solidago villosicarpa is currently ranked G1 (critically imperiled globally) by NatureServe (2003) and S1 (critically imperiled in North Carolina) by the NCNHP. It is known historically from specimens collected in Brunswick Co., N.C., in 1949 and 1950, and from a specimen collected in New Hanover Co., N.C., in 1963. It is currently known from three sites in Onslow Co., N.C. (all within Camp Lejeune Marine Corps Base), and from one site in Pender Co., N.C. The historical populations in Brunswick and New Hanover counties have not been relocated. (Although there are two historical collections from Brunswick Co., there is no data to indicate that they represent more than one site.) Global range is shown in Figure 1.

Federal status (candidate): No

If a current candidate, list the candidate priority number: Not applicable.

State status (if any): *Solidago villosicarpa* is listed as Significantly Rare - Limited (SR-L) by NCNHP.

NatureServe Conservation Status Rank:

Global Rank: G1
State Rank(s): North Carolina: S1

Current population levels rangewide: 4 current populations.

Current population levels on DOD lands. Include percentage of total population that is found on DOD installations. Also describe planning level survey information (dates, intensity, frequency):

Three of the four currently known global populations occur at Camp Lejeune Marine Corps Base.

Species Description and Life History:

Species description: *Solidago villosicarpa* is distinctive among goldenrods by its combination of pubescent stems, glabrous to glabrate leaves, thyrsoid inflorescence, and large heads with bright lemon-yellow rays, densely villous achenes, and late flowering. Basally, it is characterized by elongate, wiry roots, a stout caudex, and a rosette of petiolate, toothed leaves with blades 7-14 cm long by 4-7 cm wide. The stem is usually solitary, up to 1.5 m tall, and pubescent with short stiff spreading or appressed hairs 0.1-0.3 mm long. Leaves are progressively smaller upwards, becoming sessile and entire. Upper (adaxial) leaf surface glabrous to sparsely pubescent with short stiff hairs mostly along the mid-nerve and larger veins; the lower (abaxial) surface glabrous to glabrate. The inflorescence is a terminal simple or paniculately branched thyrse (a narrow, elongate inflorescence composed of cymose clusters of flower heads on short petioles and branchlets). When the inflorescence is simple (elongate terminal thyrse), the axis is bracteate, straight, narrow, cylindric, and 7-22 cm long by 3-6 cm wide. When the inflorescence is paniculate, it produces ascending-diverging branches up to 20 cm long that are similarly narrow and elongate. The short branches and peduncles of the cymose flower head clusters are covered with curved and straight stiff hairs 0.1-0.4 mm long. Peduncles are 0.5-9 mm long. Heads at flowering (anthesis) are 1.4-1.7 cm wide measured from ray tip to ray tip, with the involucre 5-8 mm long by 3-5 mm wide at anthesis. The involucre widens to 6-8 mm at the summit during fruiting. Outer phyllaries are short, ovate, somewhat cucullate (hood-shaped), 1.0-2.0 mm wide, and appressed. Inner phyllaries are longer and broadly linear, 0.8-1.5 mm wide, with rounded to subacute apices becoming somewhat squarrose (spreading-recurved) in age, and the margins often lacerate or long-ciliate toward the summit with cilia 0.1-0.3 mm long. Ray florets are 4-8 per head, with limb of living plants 5-7.5 mm long, 1-2 mm wide, and bright lemon-yellow. Disk florets are 10-18 per head, the corolla lobes 1.5-2.2 mm long, and the entire disk corolla 4.9-6.8 mm long. Pappus is (4.2-) 4.7-6.1 mm long. Achenes are villous with ascending hairs 0.3-0.5 (-0.7) mm long, the hairs obscuring the achene surface. Mature achenes are 2.6-2.9 mm long.

Life history and phenology: Because of the recent discovery of this species (as a distinct entity) and few current populations, little is known about its life history. It is a perennial that begins above-ground growth as a basal rosette. Observation suggests that it remains in the rosette (vegetative) stage for at least the first year, and probably longer. Observation also suggests that populations are more vigorous in response to light (e.g., canopy openings), resulting in more individuals flowering, more robust plants, a greater likelihood of paniculate inflorescences, and an increase in number of rosettes.

The Camp Lejeune Marine Corps Base populations begin flowering in early October, with some flowers observed as late as November 8 within populations that were mostly fruiting.

The Pender Co. population matured earlier than the Camp Lejeune Marine Corps Base populations during both years of observation (1998, 2003), with flowering first observed September 15 and late anthesis/fruit development by mid-October. Latest collection date in fruit is November 29 (New Hanover Co. 1963 collection).

Reproduction: Based on evidence at populations observed in the Camp Lejeune Marine Corps Base, the species appears to respond positively to increased light; specifically, in canopy openings created by hurricane blowdowns in populations at the coastal edge. There was an observed marked increase in both rosette production and flowering stems in openings created during the 1996-1998 hurricane activity at the Salliers Bay population, with no increase observed at the more inland French's Creek population, where the same hurricane period did not create canopy openings. These observations also suggest that the species produces new rosettes under favorable conditions, and by inference that seeds are fertile.

Disease and predation: A suspected fungal leaf spot has been seen on late-season leaves. After viewing a specimen, the N.C. State University Plant Disease & Insect Clinic suggested that this pathogen "is of little consequence and probably shows up every year as leaves begin to senesce" (Creswell 2003). The clinic suggested further examination if the fungus shows up earlier in the growing season, but noted that fungi are common on U.S. *Solidago* spp. Severed stems were observed at the Salliers Bay population in Camp Lejeune Marine Corps Base in 1995, apparently from grazing, but this does not appear to be a common occurrence.

Survival and mortality: The observed range of vegetative rosette size (from less than 2 cm to 30 cm across or more) and culm height (0.5-1.5 m) suggests the life history is likely longer than two years for individual plants, though this remains to be confirmed. The stout caudices of larger plants (1-1.5 cm in diameter) also suggests multi-year growth. There is no data on mortality, but positive response to light suggests that long-term dense shading may decrease life spans of individuals and be fatal to populations.

Geographic spacing of populations: All current and historical populations occur along a 70-mile stretch of coastline in southeastern North Carolina from the Gillet's Creek area northeast of New River Inlet in Onslow Co. southwest to Long Beach (Oak Island) in Brunswick Co. (Figure 1). The range extends inland seven air miles at the French's Creek population in Onslow Co., and 16 air miles at the Pender Co. population (each of these inland populations is within 1/4 mile of tidal habitats).

The three Onslow Co. populations (all in Camp Lejeune Marine Corps Base) form a group occurring within an area of about five miles by 1.5 miles. The Pender Co. population and the historical New Hanover Co. and Brunswick Co. populations are scattered over an area of about 36 miles by 11 miles in a region much more heavily altered by human development.

Population/subpopulation size and density of individuals: Size of individual subpopulations ranges from 150 square meters to 1.5 hectares. Plant density is variable, with density of

plants/meter ranging from 0.01 to 0.67 based on observed population size and cover estimates. However, density estimates could increase if study plots are established, as more detailed counts are likely to reveal a greater number of plants, especially small rosettes.

Number of individuals by age class: Estimated counts of individuals in populations range from 100-1400 individuals, with the number of fertile individuals (budding, flowering, or fruiting) ranging from 16% to 83%, but with a median of around 25%.

Population trends: Insufficient data exists to predict the sustainability, decline, or growth of individual populations, but increased light (e.g., from hurricane-caused canopy openings) appears to be an important factor for increased production of both flowering plants and sterile rosettes. Detailed demographic studies have not been done for these populations, but are recommended. Such studies will be important for assessing long term population viability.

4. Habitat Requirements

Summarize the species general habitat requirements:

Based on the data and observations discussed in Appendix A, it is inferred that *Solidago villosicarpa* can inhabit a variety of soil moisture conditions and natural community types, but always in association with a maritime influence (including freshwater tidal habitats). The historical collections from Long Beach in Brunswick Co. suggest the Maritime Shrub and Maritime Evergreen Forest communities of dry to wet-mesic barrier beach sands, although no extant populations are known from these communities.

Extant populations occur at mainland areas either along the coast or adjacent to inland tidal systems on upland terraces that gradually to abruptly slope to adjacent tidelands (swamps, marshes, or creeks). None of the four extant populations occurs in habitat that is in its historical natural condition.

The most likely natural community types at these sites are Dry Oak–Hickory Forest, Dry-Mesic Oak–Hickory Forest, and mesic Coastal Fringe Evergreen Forest (Schafale and Weakley 1990). These communities are characterized by moderately dense to dense canopies of oak, hickory, and pine with variable understory and ground layer densities.

Although the goldenrod can occur with *Pinus palustris*, there is no evidence to suggest that it is adapted to a fire-dependent longleaf pine community. To date, no *Solidago villosicarpa* plants have been found in habitat dominated by *Pinus palustris* or *Aristida stricta*. The most likely situations for a natural co-occurrence of the goldenrod and longleaf pine would be in Coastal Fringe Evergreen Forest, or in the upslope ecotone of an oak–hickory community with a longleaf pine sandhill community. In each of these situations longleaf pine is typically a non-dominant component when present.

Describe the habitat conditions on DOD lands that sustain permanent or seasonal use by the species:

Although the goldenrod's natural habitat may have burned on occasion, it likely would have burned with much less frequency than occurs in habitats where longleaf pine is the canopy dominant. Instead, the goldenrod appears to be more dependent on storm blowdowns to create open habitat, as suggested by population response to hurricane openings created in 1996. Flower and seed production appeared to increase in these storm-created canopy openings, and the species may be dependent on them for survival.

Populations have also been observed flowering in more shaded conditions, but with fewer and less robust individuals. It is probable that prolonged full shading is detrimental and potentially fatal to populations. The goldenrod also occurs in openings created by roadbeds.

Based on roadside population characteristics of many other rare species, it is probable that the extant goldenrod roadside populations occur where the goldenrod was already present naturally (at least in the seed bank), and the roadbed provided a suitable opening

5. Threats to the Species

Describe the major threats to the species rangewide:

Populations of *Solidago villosicarpa* are most likely to be extirpated by land alteration, particularly those activities that impact the ground surface, such as preparation or alteration for agriculture (including pine plantations) or infrastructure uses. Extant populations also appear to be vulnerable to extended shading. Roadside populations are threatened by any road improvement activities (widening or paving would likely destroy the populations). Also, mowing during the growing season / reproductive period would likely negatively affect seed production.

How well understood are the threats to the species?

Little is known about the life history, habitat requirements, and threats to this species. Current knowledge is essentially restricted to infrequent and casual observations of the four known extant populations first found in 1991 (1), 1995 (1), and 1998 (2).

What are the specific threats to the species on DOD installations where it occurs?

At Camp Lejeune Marine Corps Base, *Solidago villosicarpa* populations are specifically threatened by any changes in current land use that would alter the ground surface. These threats include any construction impacts associated with the camp's infrastructure.

Although no studies have been conducted, it appears at this time that troop training activity involving pedestrian use of the species' habitat at current levels is not detrimental to the species. However, use of vehicles, digging of holes and trenches, and bivouacs in the species' habitat would be threats. It also appears that prolonged heavy shading is potentially a threat to the

species. Invasion of habitat by native or non-native species (including Mimosa, *Albizia julibrissin*) would likely suppress growth and flowering.

6. Regional Conservation Actions

Describe surrounding lands (ownership, management, etc.) where species occurs outside of DOD installations:

There is a single extant population of *Solidago villosicarpa* outside of Camp Lejeune Marine Corps Base, on private land (the Godwin Tract) in Pender Co. about 25 miles southwest of the western edge of Camp Lejeune Marine Corps Base's Great Sandy Run Area, and about 40 miles southwest of the nearest *S. villosicarpa* population in Camp Lejeune Marine Corps Base. The tract is currently managed for hunting and fishing, and for other natural values (Long 2003). The historical sites in New Hanover Co. and Brunswick Co. have not been relocated; both occur in areas of substantial residential and commercial development.

Briefly describe any previous or current conservation management plan for this species on these surrounding lands:

There are no present or past conservation efforts for this species on surrounding lands. Landowners have been contacted and a site visit was conducted to educate the landowners about the significance of this population and best management practices. Although the landowners expressed a general interest in protecting the species, no formal conservation agreement was developed. Representatives from the USFWS will contact the landowners about options for candidate conservation agreements or other appropriate conservation agreements.

Describe the conservation objective of this management plan on surrounding lands:

Not applicable.

How can land managers/owners address the threats to the species on surrounding lands where it occurs? Describe the specific actions needed to meet the conservation objective.

A management plan for *Solidago villosicarpa* should include a thorough survey to determine the extent of the population, and the extent of suitable habitat. Any activity that disturbs the soil surface where plants are located should be avoided. Habitat should be analyzed to determine whether the canopy should be thinned or openings created, and whether shrub competition needs to be reduced in the ground layer. Any such thinnings, openings, or reductions should be done in a manner that minimizes surface disturbance, and avoids disturbance to individual goldenrod plants. Habitat should also be analyzed to determine the historic (natural) fire frequency, with prescribed burns conducted if appropriate (see comments under "4. Habitat Requirements" above).

What other conservation actions can land managers/owners undertake to benefit this species?

Landowners should consider formal protective action, such as donation or sale of title or easement to a conservation organization such as the NC Plant Conservation Program (NCPCP), The Nature Conservancy, or a regional land trust.

Owners who wish to retain full ownership but manage the tract in a natural state should consider the Registry Program with the NCNHP. Benefits of this voluntary program include assistance with development of management prescriptions. Landowners should also consider a Candidate Conservation Agreement with the USFWS. Under such an agreement, landowners would voluntarily commit to implementing specific actions to remove or reduce threats to the species, in return for assurances that their conservation efforts would not result in future regulatory obligations in excess of those explicitly stated in the agreement.

Additionally, germplasm from all populations should be collected and stored by the regional Center for Plant Conservation (CPC) repository (the North Carolina Botanical Garden), as insurance against unforeseen population disturbance or destruction.

7. DOD Conservation Actions

Briefly describe any previous or current conservation efforts for this species on DOD lands:

DOD has marked the Sallier's Bay site to be excluded from a timber harvest and subsequent site preparation. DOD has also done some exotic species control (cutting *Albizia julibrissin),* which threatened to shade one *Solidago villosicarpa* population.

Describe the conservation objective of this management plan on DOD lands:

The goal of these management guidelines is to ensure the long-term survival of the target species at Camp Lejeune Marine Corps Base. The primary management objective is to allow a decrease of no more than 30% in the number of individuals in each of three *Solidago villosicarpa* populations during the 10-year period following development of these management guidelines. If at anytime during the agreement period the population reduction exceeds 30% below baseline (2004) levels, or if warranted by other threats, then management practices will be reviewed by DOD, USFWS, and NCNHP and alternative management and monitoring strategies may be recommended. The number of individuals will be determined either by counting each stem (census) or by appropriate sampling methods. Data will be collected each year after the onset of flowering for 10 years (2004-2013). The number of individuals, aerial extent of population, and percentage of individuals in flower, fruit, and vegetative condition will be the critical factors in assessing management goals. Additional information including evidence of herbivory, signs of disease, pollinators, seedling recruitment, and trends associated with habitat features (such as fire, hurricanes, traffic, or invasive species) will be noted.

How can DOD address the threats to the species on DOD installations where it occurs? Describe the specific actions needed to meet the conservation objective.

The two primary threats to the species on DOD installations appear to be land alteration by humans and shading from surrounding vegetation.

Land alteration includes conversion of habitat to agriculture or silviculture, road construction, road improvement such as widening or paving, and soil compaction due to heavy vehicular or foot traffic. These threats can be addressed by preventing these activities in areas inhabited by the target species. Use of motorized vehicles, digging holes, trenches, and bivouacs in the habitat should be avoided. Note that current levels of troop training in the population areas do not appear to be detrimental to the species.

Shading by surrounding vegetation apparently reduces both the size of populations (number of individuals) and fertility (flower and seed production). Historically, hurricanes appear to have created canopy openings. However, because the species has declined to only four remaining populations, it may not be advisable to rely solely on hurricanes to create canopy openings. It may be necessary for the DOD to augment natural disturbances with periodic thinning of the canopy by mechanical means or fire. Although fire is not thought to have played a major role in the natural habitat occupied by the species, the use of fire may be a more cost-effective method of maintaining canopy gaps than removing vegetation mechanically. The effects of fire on the species are currently unknown and should be well-studied before they are applied wholesale. Overall, the DOD should investigate the most appropriate methods of maintaining canopy gaps in populations and apply those methods as needed to promote healthy populations as described in sections 8 and 9 of these guidelines.

What other conservation actions will DOD undertake to benefit this species on DOD lands or elsewhere? Will DOD work with any partners in this effort? If so, list and describe partners. (Recommended regional partners include USFWS field office and state Natural Heritage Programs, and The Nature Conservancy.)

Maintain Habitat: DOD will maintain habitat in favorable conditions for the species as described in Section 7 (above). DOD will monitor all occurrences at Camp Lejeune Marine Corps Base and collect data that will be used in assessing success of habitat management measures, population trends, and long-term viability of populations. Partners: NCNHP, NCPCP and USFWS (Raleigh Field Office) will help develop monitoring protocols.

Collect Germplasm: DOD will collect germplasm from all occurrences at Camp Lejeune Marine Corps Base and send them to the North Carolina Botanical Garden, as insurance against unforseen population disturbance or destruction. DOD will follow approved CPC protocols for collecting seeds. Partner: North Carolina Botanical Garden CPC Program.

Study Natural History: DOD will gather information about the life history of the species by monitoring individual rosettes from germination through death and recording information including number of years to flowering/fruiting and how many years individuals produce flowers before dying. DOD may work with other partners in this endeavor. Inasmuch as the USFWS

(Raleigh Field Office) will be the central repository for information gathered in the above activities, the USFWS is also a partner in these conservation actions.

8. Measuring Effectiveness of Conservation Actions

Describe the expected benefits of these conservation actions to the species (e.g., increase in population numbers, restoration of habitat, removal of threat):

Maintain Habitat: Maintaining habitat with canopy openings is expected to increase number of rosettes within populations, increase flowering and fruiting, and promote overall health of populations as evidenced by size and vigor of individuals and aerial extent of the population.

Collect Germplasm: Collecting germplasm (seeds) and storing them at an appropriate repository *ex situ* will serve as insurance against unforeseen population disturbance or destruction. If a population is unexpectedly extirpated or reduced below a critical level, the germplasm will be used to augment or re-establish populations. The germplasm may also be used for research including methods of germination, propagation, seed storage protocols, reproductive biology, soil fertility requirements, taxonomic studies, or other appropriate uses important for the conservation of the species.

Study Natural History: Understanding the sequence of events from seed germination through seed production and dispersal will be essential for identifying critical or limiting factors for each population.

How can DOD measure the effectiveness of the conservation actions?

- **describe parameters to be used to demonstrate achievement of objectives**
- **describe standards for the parameters by which progress can be measured**

Maintain Habitat: DOD will monitor all occurrences at Camp Lejeune Marine Corps Base and collect data that will be used in assessing success of habitat management measures, population trends, and long-term viability of populations. Monitoring methods are described in Section 9 of this document.

Collect Germplasm: Seeds will be collected according CPC protocols: Seeds from 40 - 50 individuals in each population at Camp Lejeune Marine Corps Base will be collected and sent to the North Carolina Botanical Garden for storage. No more than 10% of the total seed production of a population should be collected in any year. If collecting from 40-50 individuals in one year would exceed 10% of seed production for that year, then seed collection should be conducted over two or more years to avoid collecting more than 10% of the seeds produced in a given year. Seeds from each plant should be stored in separate containers. The North Carolina Botanical Garden will desiccate the seeds and store them at -20 degrees F.

Study Natural History: The DOD will monitor several individual rosettes during the number of years necessary to answer the following questions about the life history of the species:

- On average, how many years after germination do individuals produce flowers, seeds, and naturally die?
- How many seasons during the life of an individual are flowers produced? At what age, on average, is the maximum number of seeds produced?
- What is the average number of seeds produced by a flower head?
- Can size parameters of an individual (stem height, diameter of rosette, length of leaves, etc) be used to estimate age or flowering (reproduction potential)?

Ten individuals growing in relative shade will be compared with ten growing in full sun, to understand the effects of shading on the life cycle. In addition, at each site during the baseline year (2004), seed plots will be established to study the percent germination of 100 seeds in one study plot and one control plot. This work may be done in partnership with other agencies.

9. Adaptive Management and Monitoring

Outline adaptive management principles to be included in management plan, if any:

If, through the annual monitoring, number of individuals in any population are observed to be less than 70% of the original baseline populations counted in 2004, or if warranted by other threats, management practices will be reviewed by DOD, USFWS, and NCNHP and alternative management and monitoring strategies may be recommended.

Describe survey and monitoring methods, including any recommended or agreed upon standards for this species:

Monitoring methods:

At each site at Camp Lejeune Marine Corps Base, area of population and number of individuals (as determined by census or sampling) will be determined for baseline standards in 2004. Annually during 2005 - 2013, number of individuals in each population be will be determined by appropriate sampling methods that will yield estimated number of individuals with 90% confidence intervals. DOD staff will work with botanists from NCNHP and NCPCP to determine appropriate sampling and monitoring methods.

Data will be collected annually after the onset of flowering. Number of individuals and percentage of individuals in flower, fruit, and vegetative condition will be the critical factors in accessing management goals. Additional information including evidence of herbivory, signs of disease, pollinators, seedling recruitment, and trends associated with habitat features (such as fire, hurricanes, traffic, or invasive species) will be noted.

If conservation measures for this species are likely to affect listed species or modify critical habitat, demonstrate that these measures will have a neutral or positive benefit and will not adversely affect listed species or critical habitat.

Conservation measures for *Solidago villosicarpa* are not expected to affect listed species or modify critical habitat for any federally listed species.

10. Species Research

Describe any on-going research programs or needs for this species:

No research is currently being conducted for *Solidago villosicarpa*. Research is needed to determine such biological factors as phenology, types and success rates of reproduction (including seed bank studies), pollination mechanisms, seed dispersal mechanisms, disease and predation, mortality, and population dynamics (density, numbers, age classes); and such habitat factors as soils, hydrology, light, plant associates, and current community structure and composition. Research is also needed to determine what type and degree of habitat manipulation may be needed to maintain or improve current numbers of individuals and populations, and whether restoration of historical natural communities is feasible or desirable. These studies are not within the scope of these guidelines.

11. Information Management

Describe provisions for managing information related to this species' management, monitoring, and research, and how this information will be tracked over time to measure effectiveness of the conservation actions:

DOD will take the lead in collecting information related to monitoring, habitat management, and research on DOD lands, with biennial reporting to NCNHP and USFWS. After 10 years of sampling, DOD will work with the USFWS and NCNHP to assess status of populations and effectiveness of management, and make recommendations for future actions.

12. Feasibility and Timetable

What is the estimated cost for achieving the objectives stated above?

- **On DOD installation(s):**
- **On surrounding lands where species occurs, if any:**

Describe the level of staffing, expertise, funding, and other resources that will be needed to implement these management guidelines.

Primary expenses will be for staffing and travel.
Estimated staff time is shown below with estimated number of hours expected to complete each task.

- Department of Defense:
  - Germplasm collection: 5 hours
  - Habitat maintenance: 8 hours each year for 10 years = 80 hours
  - Population Monitoring: 16 hours each year for 10 years = 160 hours
  - Data entry and analysis: 3 hours each year for 10 years = 30 hours
  - Life History Studies: 8 hours each year for 10 years = 80 hours

- TOTAL hours over the 10 year period: 355 (approximately 35 hours each year after the baseline year)

- Regional partners (USFWS, Natural Heritage Programs, others):
  USFWS
  - Population Monitoring: 8 hours each year for 2 years (developing and implementing initial monitoring) = 16 hours
  - Data entry and analysis: 2 hours each year for 5 years (biennially) = 10 hours
  - Life History Studies: 8 hours for 1 year (developing study techniques) = 8 hours
  - TOTAL hours over the 10 year period: 34

  NCNHP
  - Population Monitoring: 16 hours each year for 2 years (developing and implementing initial monitoring) = 32 hours
  - Data entry and analysis: 2 hours each year for 5 years (biennially) = 10 hours
  - Life History Studies: 8 hours for 1 year (developing study techniques) = 8 hours
  - TOTAL hours over the 10 period: 50

  NCPCP
  - Population Monitoring: 16 hours each year for 2 years (developing and implementing initial monitoring) = 16 hours
  - Data entry and analysis: 2 hours each year for 5 years (biennially) = 10 hours
  - TOTAL hours over the 10 period: 26

What is the legal authority of DOD to implement the above-stated conservation actions on the relevant DOD installations?

Because *Solidago villosicarpa* is not listed as a federally threatened or endangered species, the DOD is under no legal obligation to protect this species on their lands.

What is the timetable for implementing the conservation actions? List dates for when specific conservation objectives will be met.

- Germplasm Collection: December 2004
- Habitat maintenance: As needed 2004 - 2013
- Population monitoring, data entry, and analysis: Annually 2004 - 2013 (biennial reports submitted to USFWS beginning 2004)
- Life History Studies: Twice yearly 2004 - 2013 (summary of findings expected 2014)

13. References Cited

Creswell, T. 2003. Personal communication to D. Suiter, Nov. 3.

Falk, D. A., and K. E. Holsinger. 1991. Genetics and Conservation of Rare Plants. New York: Oxford University Press.

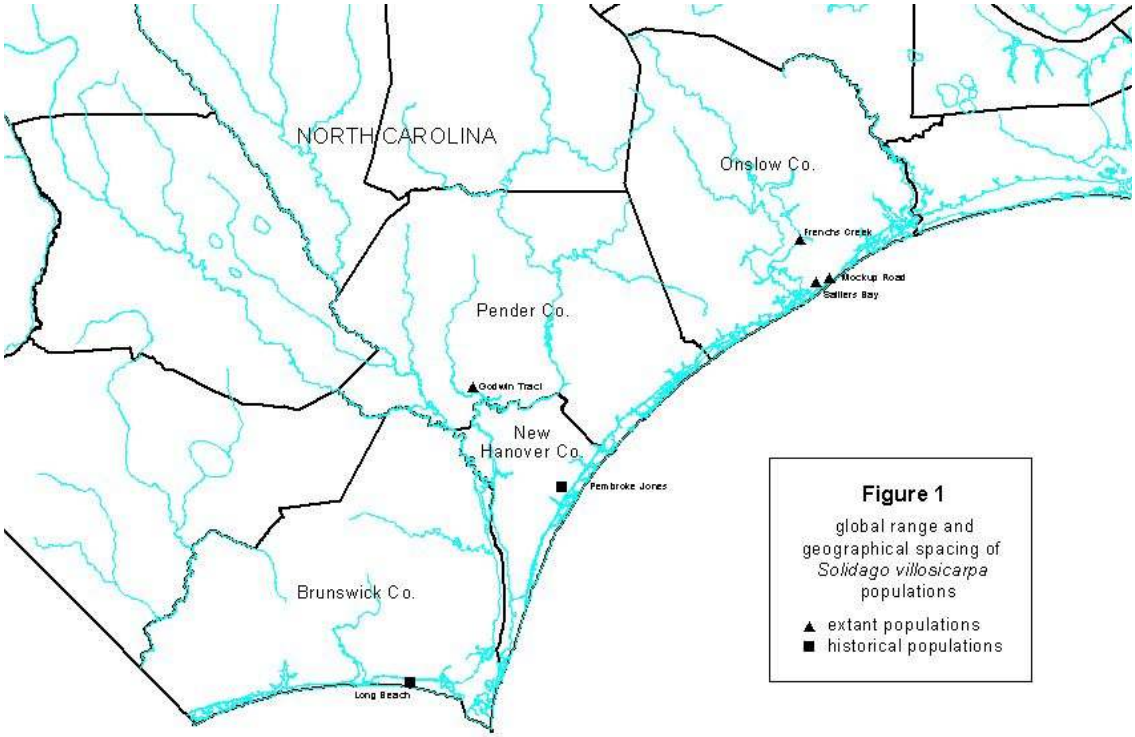
LeBlond, R.J. 2000. *Solidago villosicarpa* (Asteraceae: Astereae), a rare new southeastern Coastal Plain endemic. Sida 19(2): 291-300.

Long, S. 2003. Personal communication of Susan Long, executor and part owner of the Godwin Tract, Oct. 15, 2003.

NatureServe. 2003. NatureServe Explorer: An online encyclopedia of life [web application]. Version 1.8. NatureServe, Arlington, Va.

Schafale, M.P., and A.S. Weakley. 1990. Classification of the natural communities of North Carolina (third approximation). North Carolina Division of Parks and Recreation, Raleigh.

Figure 1. Global range and geographical spacing of *Solidago villosicarpa* populations.



APPENDIX A: Habitat Requirements of *Solidago villosicarpa*

Richard LeBlond, North Carolina Natural Heritage Program, Nov. 19, 2003

None of the four extant populations occurs in habitat that is in its original (pre-Columbian) natural condition. All of the sites have been altered by past logging, roadbed construction, fire suppression, and/or planting of loblolly pine. Thus the indigenous natural community must be inferred from historical records, soil classification, and current plant associations.

Historical records: According to specimen labels, the 1949 and 1950 Brunswick County collections of *Solidago villosicarpa* are from "live-oak scrub" and "live-oak scrub thickets" on the Long Beach coastal barrier beach. This is most likely Maritime Shrub (Schafale and Weakley 1990) (*Quercus virginiana* - {*Ilex vomitoria*} Shrubland in NatureServe 2003). Maritime Shrub most often occurs in areas exposed to the ocean and wind-borne sand and salt spray. It is characterized by a dense growth of stunted *Juniperus virginiana* var. *silicicola* and *Quercus virginiana,* and such shrubs as *Morella cerifera, Ilex vomitoria,* and *Baccharis halimifolia*. In more protected areas on similar soils, Maritime Shrub is replaced by Maritime Evergreen Forest (Schafale and Weakley 1990) (*Quercus virginiana - Quercus hemisphaerica - Pinus taeda/Persea borbonia* Forest in NatureServe 2003). Both Maritime Evergreen Forest and Maritime Shrub occur on soils usually classified as moderately well drained to somewhat poorly drained Newhan, Corolla, or Duckston fine sand entisols, with moisture content generally xeric to mesic (and probably xeric to wet-mesic in Maritime Shrub). From personal observation, Maritime Evergreen Forest might be more suitable for *Solidago villosicarpa* than Maritime Shrub because it is more likely to experience openings created by storm blowdowns (however, there are no known extant populations for the goldenrod in either of these maritime communities). Maritime Evergreen Forest also appears to have a closer relationship to communities on the mainland edge that likely occurred where *Solidago villosicarpa* is currently found, especially Coastal Fringe Evergreen Forest (Schafale and Weakley 1990) (*Quercus virginiana - Quercus hemisphaerica - Pinus taeda - Quercus falcata / Ilex vomitoria* Forest in NatureServe 2003).

The habitat for the New Hanover Co. historical site is "sandy roadside" at Pembroke Jones Park (no longer extant) approximately 1 mile inland from the mainland edge at Wrightsville Beach. The exact site unknown.

Soil classification: Soil classification can be a useful tool in determining what plant association might occur at a given site, since particular soil units within a region tend to support the same plant association or group of associations from site to site under similar natural conditions (e.g., fire frequency). This tool must be used cautiously, as mapped soil units usually contain smaller amounts of other soil units. That said, an examination of soils at known *Solidago villosicarpa* sites, in combination with present-day plant associations, may shed light on the historical–and thus target–natural community. At the French's Creek population in Camp Lejeune, the goldenrod occurs primarily on Marvyn loamy fine sand, a well drained ultisol, and in an ecotone of Marvyn soil with Norfolk loamy fine sand, also a well drained ultisol. At the Salliers Bay site in Camp Lejeune, it occurs on Wando fine sand, an excessively drained entisol. At the Mockup

Road site in Camp Lejeune, it occurs on Wando fine sand, and on Pactolus fine sand, a moderately well drained to somewhat poorly drained entisol. At the Godwin Tract in Pender Co., the goldenrod occurs on Baymeade fine sand, a well drained ultisol.
Plant associations at extant sites: Only *Pinus taeda* occurs at all five populations/subpopulations where plant species have been recorded (Table 1.). Species occurring at three or four sites are *Hypericum hypericoides, Morella cerifera, Symplocos tinctoria, Vitis rotundifolia, Chasmanthium laxum,* and *Hieracium gronovii*. These species (including *P. taeda*) are indigenous to the areas where the goldenrod populations occur, are found in a variety of natural community types (e.g., longleaf pine communities and dry to mesic hardwoods), and are also disturbance tolerant. They do not by themselves point towards any specific natural community or groups of communities. Canopy and subcanopy trees are more suggestive. Besides *Pinus taeda*, oaks and hickories are prominent to dominant at four of the sites, especially *Quercus falcata, Q. nigra, Q. stellata,* and *Carya glabra* var. *megacarpa*. Other oaks and hickories include *Quercus alba, Q. margarettiae, Q. velutina, Q. virginiana, Carya alba,* and *C. pallida*. By themselves, canopy and subcanopy trees are most suggestive of Dry Oak–Hickory Forest (Schafale and Weakley 1990) (*Quercus stellata-Quercus falcata-Carya alba/Vaccinium* spp. Coastal Plain Forest in NatureServe 2003) and Dry-Mesic Oak–Hickory Forest (Schafale and Weakley 1990). Many of the species in Table 1, especially in the shrub and herb layers, also are found in mesic to wet-mesic situations, and some at the Godwin Tract are characteristic of wet soils.

Another potentially important component in determining community types is the presence of species characteristic of the coastal zone: *Quercus virginiana* at Salliers Bay Type Site and French's Creek Bluff, and *Carya glabra* var. *megacarpa* at Mockup Road and French's Creek Bluff. These combined with the prominence of *Quercus falcata* and *Pinus taeda* suggest the Coastal Fringe Evergreen Forest.

Also to be considered are the wetter situations encountered at the Mockup Road and Godwin Tract sites. At Mockup Road, as much as half of the population occurs on soil classified as Pactolus fine sand that appears to be poorly drained in this area, and likely supported a wet longleaf pine savanna community historically (Frost 2001). However, almost all of the *Solidago villosicarpa* plants in the Pactolus area are on roadbed fill, and plants occur away from the road only where it crosses dry areas that are likely inclusions of Wando soil.

At first glance, the situation at the Godwin Tract in Pender Co. appears to differ markedly from the Camp Lejeune populations. The goldenrod plants are found along a roadbed descending a slope from a longleaf pine sandhill community to a pocosin drain community. Among the goldenrod's associates here are *Cyrilla racemiflora, Gordonia lasianthus, Ilex coriacea,* and *Lyonia lucida*–all wetland species. Facultative to dry-facultative species are also present, including *Hypericum hypericoides, Vaccinium arboreum, Hieraceum gronovii,* and *Solidago odora*. Together, these species are indicative of the range of moisture encountered (and tolerated) by *Solidago villosicarpa* on the slope. At this site, upland sandhill habitat adjacent to the roadbed is Xeric Sandhill Scrub (Schafale and Weakley 1990) (*Pinus palustris / Quercus laevis / Gaylussacia dumosa var. dumosa / Aristida stricta* Woodland in NatureServe 2003), with a canopy of *Pinus palustris* over a subcanopy of *Quercus laevis* and a ground layer of *Aristida stricta*. The adjacent intermittent drain is suggestive of Streamhead Pocosin (Schafale and

Weakley 1990) (*Pinus serotina-{Liriodendron tulipifera}/Lyonia lucida-Clethra alnifolia-Ilex glabra* Woodland in NatureServe 2003). The canopy includes *Liriodendron tulipifera, Quercus nigra, Pinus taeda,* and *Nyssa biflora* over a subcanopy of *Gordonia* and *Osmanthus americanus,* and a shrub layer of *Morella cerifera, Lyonia lucida, Chionanthus virginicus, Ilex coriacea,* and *I. glabra*. This compostion is likely influenced by past disturbance as well as the narrowness of the drain, but the occurrence of *Osmanthus* is another indication of coastal influence. Although 16 air miles inland, this site is within 100 m of tidal swamp habitat on Long Creek.

Topographically, both the Godwin Tract and French's Creek Bluff populations are at least in part on slopes, and the goldenrod appears to have a fairly wide soil moisture amplitude, from dry-mesic downslope to wet-mesic. At the French's Creek Bluff site, the majority of plants are found on the terrace at the bluff summit, but plants also occur on the face of the short but steep bluff above the creek down to the base of the slope.

The presence or adjacency of *Pinus palustris* is also of note. It occurs in juvenile form with the goldenrod at the Godwin Tract, and is dominant in adjacent sandhill habitat. It was also likely dominant near or at a portion of the French's Creek Weil Point Road subpopulation historically. Immature longleaf pine trees have also been observed near the Salliers Bay Type Site subpopulation, including between the goldenrod and the ocean.

References Cited

Frost, Cecil C. 2001. Presettlement vegetation and natural fire regimes of Camp Lejeune, Onslow County, North Carolina. Report for the U.S. Marine Corps, Camp Lejeune, NC.

NatureServe. 2003. NatureServe Explorer: An online encyclopedia of life [web application]. Version 1.8. NatureServe, Arlington, Va..

Schafale, M.P., and A.S. Weakley. 1990. Classification of the natural communities of North Carolina (third approximation). North Carolina Division of Parks and Recreation, Raleigh.

Table 1. *Solidago villosicarpa* habitat associates.

1 - Salliers Bay Type Site subpopulation
2 - Mockup Road population
3 - French's Creek Bluff subpopulation
4 - French's Creek Weil Point Road subpopulation
5 - Godwin Tract population

Canopy	**1**	**2**	**3**	**4**	**5**
Carya alba		x			
C. glabra var. megacarpa		x	x		
C. pallida			x		
Pinus taeda	D	x	x	D	x
Quercus alba			x		
Q. falcata			x	x	
Q. nigra		x	x		
Q. stellata			x		
Subcanopy	**1**	**2**	**3**	**4**	**5**
Castanea pumila		x			
Ilex opaca		x			
Liquidambar styraciflua	x	x			
Quercus falcata	x			D	
Q. margarettiae	x				
Q. nigra	x				
Q. stellata	x				
Q. velutina				x	
Q. virginiana	x				
Shrubs	**1**	**2**	**3**	**4**	**5**
Acer rubrum var. trilobum					x
Albizia julibrissin (removed in 2003)	x				
Arundinaria tecta	x				
Clethra alnifolia					x
Cyrilla racemiflora					x
Diospyros virginiana	x				

Gaylussacia frondosa			D		
Gordonia lasianthus					x
Hamamelis virginiana		x	x		
Hypericum hypericoides	x	x		x	x
Ilex coriacea					x
I. opaca					x
Liquidambar styraciflua	x			D	
Liriodendron tulipifera					x
Lyonia lucida					x
Morella cerifera	x		x		x
Oxydendrum arboreum			x		
Persea palustris	x		x		
Pinus palustris					x
Quercus alba	x				
Q. nigra	x				x
Q. virginiana	x		x		
Rhus copallina	x				x
Sassafras albidum	x				
Stewartia malacodendron			x		
Symplocos tinctoria	x		x	x	
Vaccinium arboreum					x
Woody vines	**1**	**2**	**3**	**4**	**5**
Gelsemium sempervirens	x				x
Smilax bona-nox	x				
S. glauca			x		
S. rotundifolia			x		x
S. smallii	x				
Vitis rotundifolia	x	x	x		x
Herbs	**1**	**2**	**3**	**4**	**5**
Agalinis fasciculata	x	x			
Andropogon glaucopsis					x
A. ternarius	x				

A. virginicus	x				x
Aristida purpurascens	x				
A. virgata				x	
Carex floridana	x				
Chamaecrista fasciculata	x				
Chasmanthium laxum	x		x	x	
Clitoria mariana	x				
Conyza canadensis	x		x		
Desmodium lineatum	x				
Dichanthelium portoricense					x
D. =Panicum lancearium	x				
Eragrostis elliottii	x				
Eupatorium capillifolium		x			
Gamochaeta purpurea (=Gnaphalium p.)	x				x
Gymnopogon ambiguus	x				
Hexastylis minor			x		
Hieracium gronovii	x		x		x
Liatris graminifolia	x		x		
Panicum anceps var. rhizomatum	x				
Pityopsis graminifolia var. latifolia	x		x		
Pteridium aquilinum var. pseudocaudatum	x				
Saccharum coarctatum	x				
Schizachyrium scoparium	x				x
Solidago fistulosa	x				
S. odora var. odora	x				x
Trichostema dichotomum	x				

APPENDIX B: Photographs

Photographs of coastal goldenrod and its habitat.
All photos by Dale Suiter, U.S. Fish and Wildlife Service.

Top left: Coastal goldenrod (*Solidago villosicarpa*)
Top right: Coastal goldenrod habitat at Salliers Bay, Camp Lejeune, North Carolina.
Bottom left: Richard LeBlond with coastal goldenrod flowering stem.

Round-Leaf Four-O'Clock

Management Guidelines for Species at Risk on Department of Defense Installations

NatureServe

Natural Heritage Program
COLORADO

NatureServe is a non-profit organization that provides
the scientific basis for effective conservation.

Citation:
Mayo, E., and D. Anderson. 2004. *Round Leaf Four-O'Clock: Management Guidelines for Species at Risk on Department of Defense Installations.* NatureServe, Arlington, Virginia.

This work was made possible with funding from the U.S. Department of Defense and the U.S. Fish and Wildlife Service.

Front cover photos: Round leaf four-o'clock and chalk barrens habitat. Photos by Susan Spackman Panjabi, Colorado Natural Heritage Program.

NatureServe
1101 Wilson Boulevard, 15th Floor
Arlington, VA 22209
703-908-1800
www.natureserve.org

ROUND-LEAF FOUR-O'CLOCK

MANAGEMENT GUIDELINES FOR SPECIES AT RISK ON DEPARTMENT OF DEFENSE INSTALLATIONS

FORT CARSON AND PIÑON CANYON MANEUVER SITE COLORADO

Ellen A. Mayo
David G. Anderson

May 2004

Primary Author
Ellen A. Mayo, Botanist/Plant Ecologist
U.S. Fish and Wildlife Service (USFWS)
764 Horizon Drive, Building B
Grand Junction, Colorado 81506
Phone: (970) 243-2778 ext. 14
Fax: (970) 245-6933
E-mail: ellen_mayo@fws.gov

David G. Anderson, Botanist
Colorado Natural Heritage Program (CNHP)
Colorado State University
8002 Campus Delivery
254 General Services Building
Fort Collins, Colorado 80523-8002
Phone: (970) 491-5857
Fax: (970) 491-3349
E-mail: dgander@lamar.colostate.edu

Gary L. Belew, Chief
Natural and Cultural Resources Division
Directorate of Environmental Compliance and Management (DECAM)
1638 Elwell Street, Building 6236
Fort Carson, Colorado 80813-4356
Phone: (719) 526-1694
Fax: (719) 526-1705
E-mail: gary.belew@carson.army.mil

TABLE OF CONTENTS

Table of Contents ..... **iv**
LIST OF TABLES AND FIGURES ..... **vi**
1. EXECUTIVE SUMMARY **1**
1.1 Species Information 1
1.2 Habitat 1
1.3 Distribution 1
1.4 Land Ownership 1
1.5 Threats Assessment 2
1.6 Conservation Actions and Recommendations 2
1.7 Monitoring and Adaptive Management 2
1.8 Feasibility 3
2. INTRODUCTION **4**
3. HABITAT **4**
3.1 Substrate 4
3.2 Plant Community 5
3.2.1 Associated Species 5
4. SPECIES INFORMATION **6**
4.1 Protection Status 6
4.1.1 Federal Status 6
4.1.2 NatureServe and the Colorado Natural Heritage Program 6
4.1.3 State of Colorado 6
4.2 Description and Life History 6
4.2.1 Species Description 6
4.2.2 Pollination Studies 7
4.3 Associated Species at Risk 7
4.3.1 Golden blazing star (*Mentzelia chrysantha* Engelmann ex Brandegee) 7
4.3.2 Pueblo goldenweed (*Oonopsis* sp.) 8
4.3.3 Arkansas River feverfew (*Bolophyta tetraneuris* (Barneby) WA Weber) 8
5. DISTRIBUTION **9**
5.1 Range-Wide 9
5.2 DOD Lands 9
5.2.1 Fort Carson 9
5.2.2 Piñon Canyon Maneuver Site 9
5.3 Private Lands (known and estimated) 10
5.4 Pueblo Reservoir and Pueblo State Wildlife Area 10
5.5 Colorado Department of Transportation 10
5.6 Bureau of Land Management 10
5.7 Comanche National Grasslands 10
5.8 Pueblo Chemical Depot (U.S. Army) 10
6. Major Threats in Order of Significance **12**
6.1 Development, Commercial and Residential 12
6.2 Mining Practices on Private Lands 12
6.3 Development of Roads or Utilities 12
6.4 Repeated Recreational Vehicle Use 12
6.5 Military Activities 13

6.6 Invasive/Alien Species 13
6.7 Grazing 13
6.8 Threats on DOD Lands 13
6.8.1 Fort Carson 13
6.8.2 Piñon Canyon Maneuver Site 14
7. REGIONAL CONSERVATION ACTIONS 14
7.1 Ecoregional Planning 14
7.2 Conservation Easements 15
7.3 Species Assessments 15
7.4 Colorado Department of Transportation Conservation Strategy 15
7.4.1 Best Management practices 15
7.4.2 Mitigation 15
7.5 Pueblo State Wildlife Area and Pueblo Reservoir State Recreation Area 15
7.6 Colorado Natural Areas Program (CNAP) 15
7.7 Comanche National Grasslands (CNG) 16
7.8 Denver Botanic Garden 16
8. DOD CONSERVATION ACTIONS 16
8.1 Conservation Easements 16
8.2 Piñon Canyon Maneuver Site 16
8.2.1 Recommended Management on PCMS 16
8.3 Fort Carson Natural Resources Management 16
8.4 Fort Carson Training Areas 17
8.4.1 Recommended Management on Training Areas 17
9. MEASURING EFFECTIVENESS OF CONSERVATION ACTIONS 17
9.1 Habitat Protection Goals, Objectives and Criteria Range-Wide 17
9.2 Colorado Natural Heritage Program Conservation Strategy 17
9.3 Recovery Goals 18
9.4 Element Occurrence Ranking (CNHP 2004) 18
9.4.1 EO Ranking Criteria 18
9.4.2 EO Ranking descriptions 19
9.4.3 EO Ranking Specifications 19
9.5 Protected Areas 21
10. ADAPTIVE MANAGEMENT AND MONITORING 22
10.1 Monitoring Recommendations 22
10.2 Monitoring Design 22
10.2.1 Rapid Occurrence Assessment 23
10.2.2 Detailed Occurrence Assessment 23
10.3 Monitoring Schedule 24
11. FEASIBILITY AND TIMETABLE 24
11.1 Monitoring 24
11.2 Conservation Easements 24
12. INFORMATION MANAGEMENT 24
12.1 Colorado Natural Heritage Program Data Synthesis and Analysis 24
12.2 Disclaimer (CNHP 2004) 25
13. REFERENCES CITED 25
14. ADDITIONAL REFERNCES 27
15. CONTACTS 27

LIST OF TABLES AND FIGURES

Tables

Table 1. Population viability ranks for surveyed populations 13
Table 2. CNHP ranks for 29 occurrences of round-leaf four-o'clock 19
Table 3. Occurrences ranked A and B in CNHP's biological conservation database 21

Figures

Figure 1. Chalk barrens habitat 4
Figure 2. Round-leaf four-o'clock 7
Figure 3. Golden blazing star 8
Figure 4. Pueblo goldenweed 8
Figure 5. Arkansas River feverfew 8
Figure 6. Distribution and ownership of round-leaf four-o'clock habitat 11
Figure 7. Land management of known populations of round-leaf four-0'clock 12
Figure 8. Round-leaf four-o'clock habitat on Fort Carson 14
Figure 9. Round-leaf four-o'clock habitat on Piñon Canyon Maneuver Site 14
Figure 10. Ownership status of 11 highest ranked occurrences of round-leaf four-o'clock. 20

1. EXECUTIVE SUMMARY

1.1 Species Information

Scientific name:	*Oxybaphus rotundifolius* (Greene) Standley
Synonym:	*Mirabilis rotundifolia* (Greene) Standley
Common name:	Round-leaf four-o'clock
Family:	Nyctaginaceae (Four-o'clock family)
DOD Installations:	Fort Carson Military Reservation, Colorado
	U.S. Army Piñon Canyon Maneuver Site (PCMS), Colorado

Round-leaf four-o'clock (*Oxybaphus rotundifolius*) is a rare species due to narrow substrate specificity, weak competitive ability, and limited extent of its habitat. The species is ranked G2 (globally imperiled) by NatureServe and S2 (state imperiled) by the Colorado Natural Heritage Program (CNHP). It is considered a "species at risk" by the U.S. Fish and Wildlife Service (USFWS), but it has no formal federal status.

This perennial plant has thick woody roots that allow it to grow on dry rocky ridges where few other plants survive. The plants are low growing, leathery leaved, covered with hairs that conserve water, and remain dormant beneath the surface during drought years. Plants have magenta flowers, produce seeds and also grow new shoots from outlying roots. Three other associated plant species at risk are similarly adapted to the same habitat: golden blazing star, Arkansas River feverfew, and Pueblo goldenweed.

1.2 Habitat

The species and its cohorts are endemic to eroded outcrops of the Niobrara Formation called chalk barrens. The chalk barrens habitat is characterized by erodable terrain, shallow soils, little water and low nutrients; a unique environment in which few plants can thrive. The plant community is open piñon/juniper woodland which generally covers less than 25% of the chalk barrens. The four endemic species comprise 7.3% of the barrens flora (The Nature Conservancy 2001).

1.3 Distribution

Surveys for round-leaf four-o'clock have documented approximately 7,300 individuals. The 29 known populations occupy about 3,436 acres of chalk barrens habitat scattered across Pueblo and Fremont Counties in the central Arkansas River Valley of south-central Colorado. There is one disjunct population on 253 acres at Piñon Canyon Maneuver Site in Las Animas County, Colorado. All are within the Central Shortgrass Prairie Ecoregion.

1.4 Land Ownership

The Department of Defense (DOD) manages at least 1,015 acres of occupied habitat on Fort Carson and 253 acres on Piñon Canyon Maneuver Site (PCMS). Altogether the habitat for plant species at risk comprises about 0.05 percent of the 373,721 acres of military lands managed by Fort Carson.

Private owners control more than 2,111 acres of occupied habitat on residential commercial, industrial and agricultural lands. The State of Colorado manages about 57 acres of occupied habitat in recreation areas and along highways.

1.5 Threats Assessment

Protection for this rare plant and its cohorts depends on preventing the destruction of the chalk barrens habitat. Residential and commercial development with its attendant gravel extraction, water reservoirs, and infrastructure is increasing dramatically in the valley. Demolition of chalk barrens to make way for development on private lands is far outpacing conservation efforts. On habitat managed by Fort Carson, the ongoing threat to the plants is repetitive ground disturbance and compaction in the training areas. Intensity and frequency of impacts from training activities have increased since an armored cavalry unit moved to Fort Carson and training of National Guard and Reserve units has escalated. There is no scientific documentation of the effects of this disturbance regime on the plant species endemic to the chalk barrens.

Information on round-leaf four-o'clock population locations, sizes and trends is maintained by the Colorado Natural Heritage Program. Botanists at CNHP report that there is unsurveyed habitat on private land, unknown numbers of plants on military land, and known populations that are being extirpated faster than the database can be updated.

1.6 Conservation Actions and Recommendations

Fort Carson is currently working with The Nature Conservancy (TNC) and private landowners to secure conservation easements on property adjacent to Fort Carson that would protect an important area of chalk barrens habitat for round-leaf four-o'clock and the other three species at risk. The Colorado Department of Transportation is also supporting the establishment of this easement as a possible mitigation for conflict areas on highway right-of-ways.

TNC is promoting awareness of the chalk barrens plants among county and regional planners. Best management practices have been developed for maintenance crews on state lands. A new conservation-planning Legacy project is expected to enhance collaboration between Fort Carson, PCMS, TNC and CNHP that will benefit species at risk.

The Colorado Natural Heritage Program recommends management efforts focused on the eleven largest populations (about 5,000 plants) of round-leaf four-o'clock that are in good to excellent condition on 48 percent (1,639 acres) of known occupied habitat. Five of these populations, including about 1,226 acres, are on DOD land.

1.7 Monitoring and Adaptive Management

A two-phased implementation of monitoring is proposed by CNHP. Rapid assessments of the eleven high quality populations would document size, condition and landscape context for each site annually. Detailed assessments would consist of establishing a sufficient number of permanent plots to evaluate the impact of disturbance regime variables on population viability. Monitoring results will be integrated into existing programs to facilitate adaptive management of the habitat for long term survival of the rare plants.

1.8 Feasibility

Fort Carson plans to collaborate with CNHP to establish an assessment and monitoring program in 2005 to document the response of the plant species at risk to military and maintenance activities on the training areas. Assessment can be accomplished with two to four weeks of field work each year. Monitoring will begin with a pilot project to design the best protocol.

The collaborative efforts of DOD, private owners, TNC, CNHP, the State of Colorado, USFWS and others can, with continued support, provide long-term management and protection for the chalk barrens habitat of round-leaf four-o'clock and associated species at risk, and preclude the need to list these species as threatened or endangered.

2 INTRODUCTION

Management for a plant species at risk involves management for a unique habitat and vegetation community within an ecoregion. This management guidance template outlines protection strategies for the round-leaf four-o'clock (*Oxybaphus rotundifolius*), a species endemic to chalk barrens of the Niobrara Formation. The Nature Conservancy (TNC) has identified the chalk barrens as an ecologically important system within the Arkansas Valley Barrens (AVB) conservation site in Fremont and Pueblo Counties and on scattered outcrops in Otero and Las Animas Counties in Colorado. The AVB are mostly in the Central Shortgrass Prairie Ecoregion (TNC 2001).

The round-leaf four-o'clock is endemic to the chalk barrens. Golden blazing star is also endemic to the same habitat, although it is not always found on the same sites with the four-o'clock. A third species at risk, Arkansas River feverfew is almost always found growing with the four-o'clock on the chalk barrens sites, and also occurs on other rocky substrates in the area. These three species at risk will all benefit from proactive multi-species habitat protection and adaptive management.

3 HABITAT

3.1 Substrate

The Niobrara Formation covers more than 50 percent of the Arkansas Valley Barrens. In most areas, the Niobrara consists solely of resistant layers of shale and limestone called the shale/limestone barrens. In some areas, however, the limestone and shale are covered by more finely-grained chalk hills known as the chalk barrens (TNC 2001, Figure 1). The chalk outcrops are often found on moderately steep slopes, but also occur on flat mesa tops.

Figure 1. Chalk Barrens Habitat. Photo by S. Spackman, CNHP, 1999.

The chalk barrens occur on the Middle Chalk and Upper Chalk units of the Smoky Hills Member. They have highly weathered bedrock on the surface, consisting of small platy pieces less than four centimeters long that form a thin surface layer with shallow mineral soil underneath. These soils are fine-grained, with about 60 percent of the particles composed of silts and clays. Soil pH ranges from moderately to strongly alkaline (7.4 to 8.3 pH) (Kelso et al. 2003).

3.2 **Plant Community**

Shale barrens often support populations of narrowly endemic species. Recent research by Kelso (2003) indicates that plant endemism on the chalk barrens is not caused by requirements for unique geochemical conditions, i.e. round-leaf four-o'clock is not a gypsophilus plant. The chalk barrens habitat is characterized by erodable terrain, shallow soils, little water and low nutrients; a unique environment in which few plants can thrive. Vegetation generally covers less than 25% of the chalk barrens; the four endemic species comprise 7.3% of the barrens flora (TNC 2001). The round-leaf four-o'clock and many of the other barrens species have woody rhizomes or roots penetrating the thin, moisture-retentive chalk strata. They can exploit a habitat that excludes other locally abundant species that are intolerant of the physical conditions (Kelso et al. 2003).

3.2.1 Associated Species

(Heckmann 1997)

Woody Species

Piñon pine	*Pinus edulis*
One-seed juniper	*Juniperus monosperma*
Bigelow's sagebrush	*Artemisia bigelovii*
Shadscale	*Atriplex confertifolia*
Gardner's saltbush	*Atriplex gardneri*
Four-wing saltbush	*Atriplex canescens*
James frankenia	*Frankenia jamesii*

Herbaceous Species

Pueblo goldenweed*****	*Oonopsis puebloensis*
Golden blazing star ******	*Mentzelia chrysantha*
Sidebells beardtongue	*Penstemon versicolor*
Arkansas River feverfew*****	*Bolophyta tetraneuris*
Limestone bladderpod*	*Lesquerella calcicola*
Oval-leaf bladderpod	*Lesquerella ovalifolia*
Indian ricegrass	*Oryzopsis hymenoides*
New Mexico feathergrass	*Stipa neomexicana*
Fendler wild buckwheat	*Eriogonum fendlerianum*
James hidden-flower	*Cryptantha jamesii*
Rocky Mountain zinnia	*Zinnia grandiflora*
Plains blackfoot	*Melampodium leucanthum*
Snakeweed	*Gutierrezia sarothrae*
Sicklepod rushpea	*Hoffmanseggia drepanocarpa*

****** sensitive and endemic to chalk barrens
***** sensitive and frequently found on chalk barrens

4 SPECIES INFORMATION

4.1 Protection Status

4.1.1 Federal Status

Round-leaf four-o'clock *(Oxybaphus rotundifolius)* is considered a "species at risk" (SAR) by the USFWS. Recovery actions are recommended to preclude the need for listing. The species was published as a category 2 candidate for listing in 1983. The category 2 list was eliminated in 1995 and the species currently has no formal federal status.

4.1.2 NatureServe and the Colorado Natural Heritage Program

The species is ranked G2 (globally imperiled) by NatureServe and S2 (state imperiled) by the Colorado Natural Heritage Program (CNHP). Globally and in Colorado the species is imperiled because of rarity (6 to 20 occurrences, or 1,000 to 3,000 individuals), or (as in this case) because other factors demonstrably make it very vulnerable to extinction throughout its range.

4.1.3 State of Colorado

There are no state laws protecting sensitive plants in Colorado.

4.2 Description and Life History

4.2.1 Species Description

Round-leaf four-o'clock plants are about 12 inches high, dying back to ground level in winter; roots are thick, woody, and a meter or more long. One population may have some individuals with one or two stems and others nearly hemispheric with many branches. Stem hairs are white, long and stiff. Leaves are leathery and exhibit a wide range of hairiness. Lower leaves are round in outline, 7 cm. long and 5 cm. wide or less, upper leaves are smaller and more pointed. Flowers are bright magenta and flared to about 2 cm. in diameter (Figure 2). The flowers are only open between dawn and about midmorning; they do not reopen in the afternoon as in other four-o'clocks. Plants are pollinated by a variety of common insects, and are also self-pollinating. Small oval fruits develop in a papery, inverted umbrella-shaped structure which breaks off and rolls or blows away when the fruits are mature. Flowering starts in early June and fruits usually develop in July.

Lateral stems originate and branch out from the rhizome, to emerge at distances up to several meters from the main stem. These outlying shoots are difficult to distinguish from separate plants. Another characteristic of the species that complicates monitoring is the ability to remain dormant underground for one or more years. The individuals emerging from dormancy are difficult to distinguish from new seedling recruits

(Heckmann 1997). Available moisture has the greatest effect on plant size and reproduction, with plants remaining virtually dormant during drought.

4.2.2 Pollination Studies

Insect visitation has been observed in the field. Documented pollinators are one species of hoverfly (*Syrphus* sp.) and four species of bees: a bumble bee (*Bombus nevadensis*), a white-banded bee (Halictinae sp.), a sweat bee (*Dialictus* sp.), and a species of *Anthophora*. Western harvester ants serve as seed dispersers and seed predators. Flowering and seed set were equally abundant with and without insect pollination (Kelso et al. 2003), but the plants probably benefit from cross-pollination facilitated by insects because cross-pollination contributes to genetic variation within the species (S.C. Spackman Panjabi 2004.)

Figure 2. Round-leaf four-o'clock. Photo by S. Spackman, CNHP, 1999.

4.3 Associated Species at Risk

The golden blazing star and Pueblo goldenweed are frequently associated with the round-leaf four-o'clock on the chalk barrens; both are endemic to Pueblo and Fremont Counties. Arkansas River feverfew is strongly associated with the chalk barrens, and also occurs in three other counties of Colorado. All three species are known to occur on Fort Carson.

4.3.1 Golden blazing star (*Mentzelia chrysantha* Engelmann ex Brandegee)

Synonym: *Nuttallia chrysantha*
Family: Loasaceae
Golden blazing star is a species at risk. Recovery actions are recommended to preclude the need for listing. CNHP ranks the species G2/S2. This is a perennial herb with thick, erect,

mostly unbranched stems, 20-60 cm tall. Flowers are lemon yellow with 10 petals (Figure 3). Flowering occurs in July-September, fruits are produced in August and September.

Figure 3. Golden blazing star
Photo by S. Spackman, CNHP, 1999

4.3.2 Pueblo goldenweed (*Oonopsis* sp.)

Family: Asteraceae

This species is newly recognized (G. Brown, unpublished); its scientific name has not yet been formally published. Pueblo goldenweed is a species at risk. Recovery actions are recommended to preclude the need for listing. CNHP ranks the species G2/S2. Plants have persistent woody stalks and yellow ray and disk flowers, strongly pubescent and reflexed phyllaries. Flowers appear in July (Figure 4).

Figure 4. Pueblo goldenweed
Photo by S. Spackman, CNHP, 1999

4.3.3 Arkansas River feverfew (*Bolophyta tetraneuris* (Barneby) WA Weber)

Synonym: *Parthenium tetraneuris*

Family: Asteraceae

Arkansas River feverfew is a sensitive species endemic to chalk and shale barrens habitats. CNHP ranks the species G3/S3 (threatened throughout its range). Plants are low and mat forming. White to pale cream disk flowers on very short stems bloom in April and May (Figure 5).

Figure 5. Arkansas River feverfew
Photo by S. Spackman, CNHP, 1999

5 DISTRIBUTION

5.1 Range-Wide

The chalk barrens are currently exposed only in the Pueblo to Cañon City area, although minor remnants exist to the southeast along the Arkansas River tributaries and into Otero and Las Animas Counties in Colorado (Figure 6). Elevation range for the round-leaf four-o'clock is 4,800 to 5,905 feet. The barrens appear as scattered outcrops ranging in length from 10 meters to a few kilometers.

The Colorado Natural Heritage Program has documented 3,436 acres of habitat occupied by the round-leaf four-o'clock. The total number of plants reported is 7,313. Both totals are based on field surveys. Surveys have not been completed for the chalk barrens habitat on all private or military lands, and counts of individual plants are inconsistent and incomplete.

5.2 DOD Lands

The chalk barrens extend onto the southern portion of Fort Carson. There is one isolated exposure of the formation on Piñon Canyon Maneuver Site.

5.2.1 Fort Carson

The extent of chalk barrens habitat known to be occupied by round-leaf four-o'clock on Fort Carson covers approximately 1,015 acres (CNHP 2004, DECAM 2004) which are used regularly for military training exercises, mechanized and otherwise, and for hunting and other recreational activities. The downrange maneuver areas where the barrens occur include about 82,000 acres.

DOD surveys for presence/absence of the species in 1995 and 1996 produced positive results at all of the 28 sites surveyed on 784 acres of training land. Additional surveys by non-military researchers in 1995 resulted in records for 231 additional acres of occupied habitat. Individual plants were not counted during DOD surveys. Plants were counted by other researchers using a variety of methods. The nine element occurrence records (locations) reported for DOD lands in Table 1 represents a consolidation of these survey sites into population sites.

5.2.2 Piñon Canyon Maneuver Site

"Gilligan's Island" is a discrete outcrop of the chalk barrens that is easily distinguished from the surrounding plains. This ridge occupies about 253 acres, or 0.1 percent of the 225,000 acres of "trainable" land area within PCMS. The barrens here are composed of Greenhorn limestone instead of the Smoky Hills chalk member. The area is posted off limits to mechanized training maneuvers but there is evidence of occasional tank activity. This population represents the southeastern limit of known distribution for the round-leaf four-o'clock.

DOD surveys for presence/absence of the plants in 1995 and 1997 produced positive results only on the 253 acres of Gilligan's Island. Surveys were conducted on an additional 3,688 acres of PCMS with negative results (CNHP 2004, DECAM 2004).

5.3 Private Lands (known and estimated)

Sixty-two percent of the known populations occur on private lands that are used for residential and commercial development, surface mining and grazing (Figure 7). Suitable chalk barrens habitat where the round-leaf four-o'clock has been found covers about 2,111 acres of private land in Pueblo and Fremont Counties (CNHP 2004). CNHP records indicate that there is unsurveyed potential habitat on private lands.

5.4 Pueblo Reservoir and Pueblo State Wildlife Area

One of the largest and most robust populations of round-leaf four-o'clock grows along the edge of Pueblo Reservoir (CNHP 2004). Proposals to raise the water level in the reservoir and construct a water pipeline from there northward are currently being evaluated. Impacts to the plants in the state areas also include hiking, camping, hunting, and outdoor theater events.

5.5 Colorado Department of Transportation

Suitable chalk barrens habitat on Colorado Department of Transportation (CDOT) right of ways is estimated to be no more than 117 acres (Grunau et al. 2003), 17 acres of which have recorded populations of round-leaf four-o'clock.

5.6 Bureau of Land Management

BLM is not included in management assessments for the round-leaf four-o'clock, because only one small population covering less than an acre has been located on BLM land (CNHP 2004).

5.7 Comanche National Grasslands

Potential habitat has been identified on the Grasslands, but no occupied habitat has been reported to date. Surveys of the scattered chalk barrens are planned for 2004.

5.8 Pueblo Chemical Depot (U.S. Army)

No habitat for round-leaf four-o'clock has been found on the Pueblo Chemical Depot during inventories conducted by CNHP (2004).

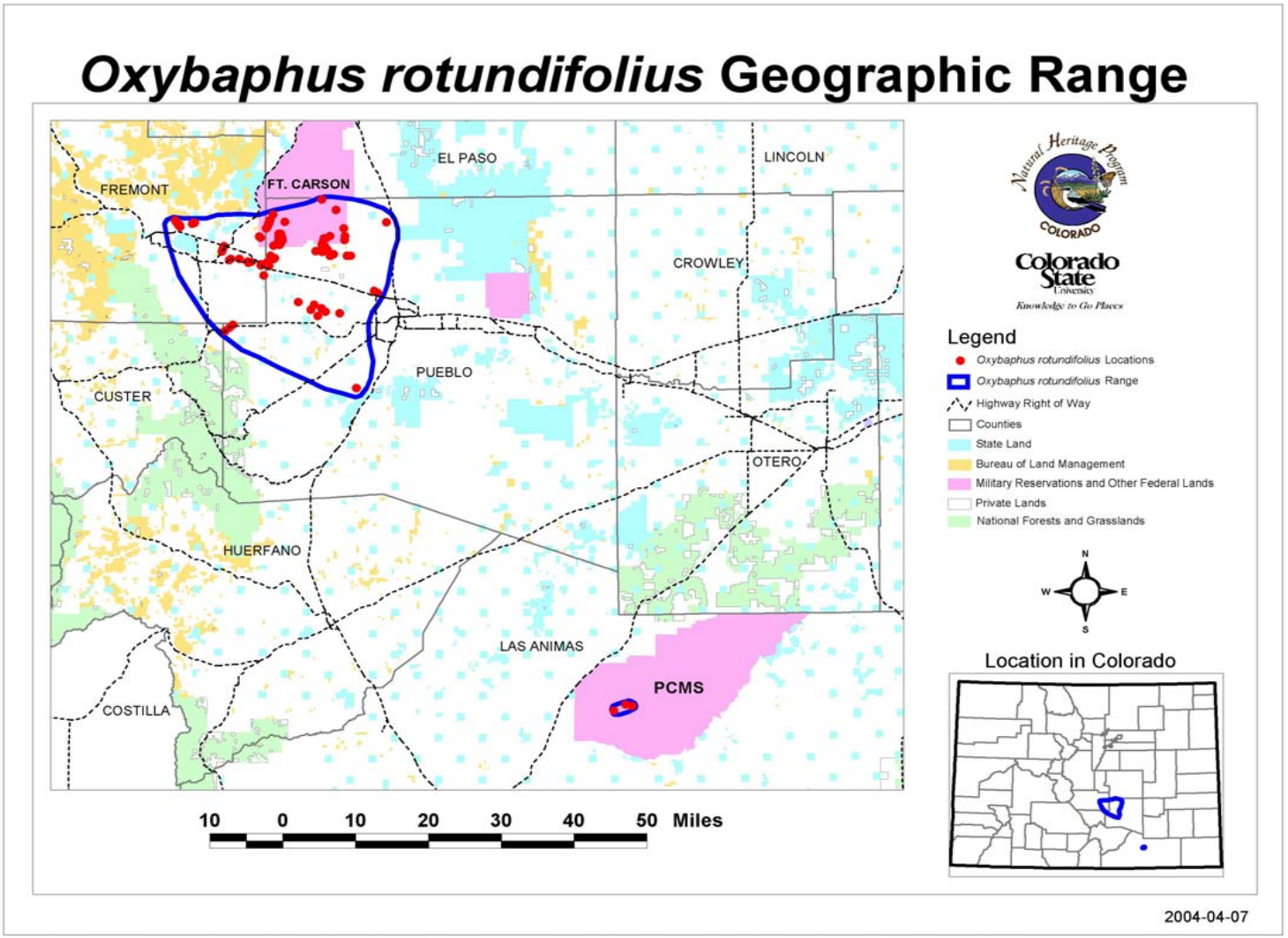
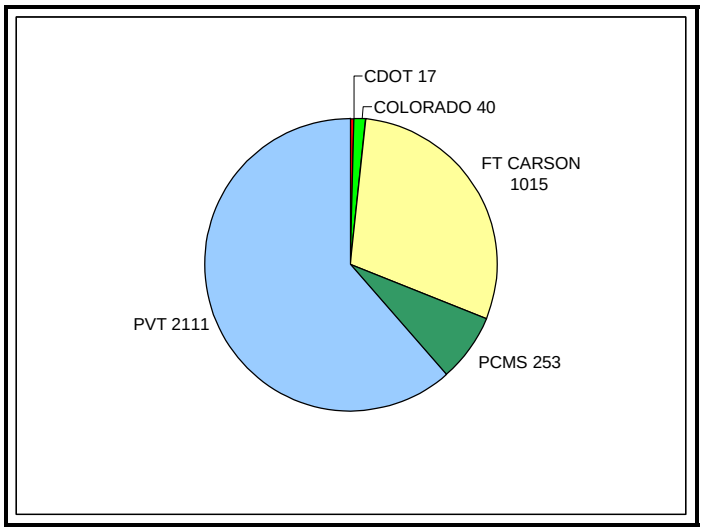


Figure 6. Distribution and Ownership of round-leaf four-o'clock Habitat. (CNHP 2004)
Locations are generalized to protect the interests of military and private land owners. See disclaimer in section 13.2.

Figure 7. Land management (in acres) of known populations of round-leaf four-o'clock

Land Status derived from Colorado Gap Analysis Land Status, 1998 (CNHP 2004).



6 MAJOR THREATS IN ORDER OF SIGNIFICANCE

6.1 Development, Commercial and Residential

An estimated 62 percent of the occupied chalk barrens habitat is privately owned. Residential development in Colorado in the Arkansas River Valley and especially Pueblo County has been increasing at a rate comparable to that of the Colorado Springs to Fort Collins corridor.

6.2 Mining Practices on Private Lands

Mining of the underlying Fort Hays limestone for cement production has destroyed some habitat, especially at the Portland limestone mine.

6.3 Development of Roads or Utilities

The Colorado Department of Transportation (CDOT) controls right of ways that comprise about 0.5 percent of known habitat for round-leaf four-o'clock. Roads, utilities and expressways are expected to keep pace with the high rate of development in the Arkansas Valley. All three of the barrens species at risk are known to occur on roadsides. The primary concerns for potential impacts to barrens species are road widening, utilities maintenance, mowing, and herbicide application (Grunau and Lavender 2002).

Raising the level of water storage and construction of a water pipeline present an imminent threat to a large population of round-leaf four-o'clock on state land. Expanded camping and recreation facilities have encouraged heavier disturbance on round-leaf four-o'clock populations.

6.4 Repeated Recreational Vehicle Use

The chalk barrens are frequently used for off-road vehicle (ORV) recreation because of their challenging slopes and the lack of interference from vegetation. Once an area shows signs of ORV tracks it encourages others to visit the site, and usage may escalate rapidly. Repeated recreational use by ORVs can destroy plants and pose a threat to round-leaf four-o'clock populations (Anderson 2003).

6.5 Military Activities

The chalk barrens seem to be preferred for military training maneuvers due to their unique combination of open ground and piñon/juniper "cover." Occasional surface disturbance may be beneficial to the plants (Kelso 2001), but as with ORVs, repetitive disturbance destroys plants and alters the habitat. Some slopes may be too steep or otherwise unsuitable for vehicles, and thus provide havens for the plants. The result may be a fragmented habitat for the round-leaf four-o'clock and its cohorts.

6.6 Invasive/Alien Species

Invasive species are considered to be only a low threat on most chalk barren sites because the substrate is not easily inhabitable by native or exotic species.

6.7 Grazing

Moderate grazing does not appear to have a negative effect on this plant. At appropriate stocking rates, animals tend not to enter the barrens because these areas have very low forage value (Anderson 2003).

Table 1. Population viability ranks for surveyed populations.

Rank	#DOD Sites	# Pvt. Sites	#State Sites	Total Sites	# Plants
Excellent	1	1	1	3	1100
Good	3	4	0	7	1614
Fair	1	6	3	10	425
Poor	3	0	0	3	29
TOTALS	8	11	4	23	3168

Based on Element occurrence ranks assigned by CNHP. Five populations are not included because data, such as number of plants, was incomplete.

6.8 Threats on DOD Lands

6.8.1 Fort Carson

The chalk barrens with their scattered piñon and juniper trees provide the cover that is desirable for military training, so the round-leaf four-o'clock and the training areas use the same habitat (Figure 8). A light to moderate level of disturbance to the plants and soil is considered tolerable for the barrens species, possibly beneficial for the round-leaf four-o'clock and other deeply rooted species adapted to shifting substrates. Beyond an unspecified tolerance threshold, frequent and repetitive disturbance destroys above-ground biomass faster than the plants can respond with new growth or new seedlings, or it can destroy the same new growth that it stimulates. Soil compaction may inhibit seedling and root sucker establishment and damage underground rhizomes. Heavy dust may reduce the photosynthetic process in the plants (Gibson et al. 1998). The impacts of these physical disturbances on the plants depend on the disturbance regime: timing, size, frequency and intensity. A monitoring program is needed to document the response of barrens endemics to various disturbance regimes. There may be steep slopes and other buffer areas of undisturbed occupied habitat that would serve as control sites.

Figure 8. Round-leaf four-o'clock habitat on Fort Carson
Photo by E. Mayo, USFWS

6.8.2 Piñon Canyon Maneuver Site

The population on PCMS is designated as an area off limits to maneuvers, but there is evidence of occasional tank activity on the site (Figure 9). There is no grazing of cattle on the site.

Figure 9. Round-leaf four-o'clock habitat on Piñon Canyon Maneuver Site
Photo by E. Mayo, USFWS

7 REGIONAL CONSERVATION ACTIONS

7.1 Ecoregional Planning

The Nature Conservancy produced an Arkansas Valley Barrens Site Conservation Plan in 2001. Four conservation strategy priorities were identified for the chalk barrens:

1. Incorporate ecological goals into county plans. A "Survey of Critical Biological Resources of Pueblo County, Colorado" (Spackman-Panjabi et al. 2003) was commissioned by the Pueblo Planning Department. This report presents all potential conservation areas identified in Pueblo County that support rare and imperiled plants, animals and significant plant communities. Pueblo County has yet to establish an open space program.
2. Build the capacity of local land trusts to protect priority areas.
3. Influence developers to avoid or minimize impacts.
4. Obtain conservation easements on high-priority tracts.

7.2 Conservation Easements

The Nature Conservancy is currently working with Fort Carson and private landowners to secure conservation easements on property adjacent to Fort Carson that would protect an important area of chalk barrens habitat for round-leaf four-o'clock and the other three species at risk. CDOT is also supporting the establishment of this easement as a possible mitigation for conflict areas on highway right-of-ways.

7.3 Species Assessments

The U.S. Forest Service is publishing a detailed species assessment for the golden blazing star that was prepared by CNHP (Anderson 2003).

7.4 Colorado Department of Transportation Conservation Strategy

The Colorado Department of Transportation has developed a conservation plan for sensitive species that may by impacted by routine maintenance and construction activities on existing state and federal highways within the Central Shortgrass Prairie ecoregion (Grunau et al. 2003). The goal of this plan is to: 1) minimize the temporary impact of routine maintenance activities by using best management practices (BMP), and 2) mitigate for construction projects that result in permanent habitat loss.

7.4.1 Best Management practices

Right of way (ROW) maintenance mowing will be scheduled after July 31 to allow round-leaf four-o'clock to produce seed. This schedule conflicts with BMP for the golden blazing star, which sets seed in late August to September. The golden blazing star occurs primarily on ROWs. To protect this species, CDOT avoidance measures will include delayed mowing until late September to protect the seed source.

7.4.2 Mitigation

Off site mitigation is the strategy proposed by CDOT for protection of habitat for round-leaf four-o'clock and Pueblo goldenweed. Under their Memorandum of Understanding (MOA) with the Colorado Division of Wildlife (CDOW), The Nature Conservancy (TNC), The Colorado Department of Natural Resources (DNR), U.S. Fish and Wildlife Service, and the Federal Highway Administration (FHWA), CDOT has identified a large potential conservation easement on private land that would include chalk barrens habitat for round-leaf four-o'clock as well as Pueblo goldenweed and Arkansas River feverfew plus the Arkansas Valley evening primrose.

7.5 Pueblo State Wildlife Area and Pueblo Reservoir State Recreation Area

Colorado Natural Areas Program planned (in 1990) to help the Division of Parks and Outdoor Recreation develop a monitoring and management plan for populations at Juniper Breaks and the west end of Pueblo Reservoir (Naumann 1990). These populations are still extant, but the monitoring plan needs to be implemented.

7.6 Colorado Natural Areas Program (CNAP)

CNAP recommended in its 1990 status report that the largest known population of round-leaf four-o'clock at Fourmile Creek be acquired and protected by TNC (Naumann 1990). The land was still for sale in 1995. Current status of this occurrence as a high quality site to be included in rapid assessment monitoring is based on the 1995 data.

7.7 Comanche National Grasslands (CNG)

CNG has identified scattered outcrops of the Smoky Hill Unit that may be potential habitat for the species. The Forest Service plans to conduct surveys of the potential habitat on CNG in 2004. If the species is found on the Grasslands, it will be considered as a species of management concern, with a management objective to maintain a viable population.

7.8 Denver Botanic Garden

The Denver Botanic Garden has been very successful at propagating round-leaf four-o'clock plants from seed and growing them in the native plant garden. The garden plants are not suitable for reintroduction to the chalk barrens, but they have been a source of information on the morphology and physiology of the species. Researchers from the gardens have also monitored round-leaf four-o'clock on a mining site for several years.

8 DOD CONSERVATION ACTIONS

8.1 Conservation Easements

Fort Carson is currently working with The Nature Conservancy and private landowners to secure conservation easements on property adjacent to Fort Carson that would protect an important area of chalk barrens habitat for round-leaf four-o'clock and the other three species at risk.

8.2 Piñon Canyon Maneuver Site

The "Gilligan's Island" population on PCMS is designated as an area off limits to maneuvers. There is no grazing of domestic livestock on PCMS. There is evidence of occasional tank activity on the round-leaf four-o'clock habitat. The area is inspected for damage to the habitat by USFWS staff after it is used for training exercises. The conservation objective for Gilligan's Island is to maintain the existing high quality habitat.

8.2.1 Recommended Management on PCMS

a. Continue the policy of excluding mechanized maneuvers on this site.
b. Monitor the habitat and demography of the round-leaf four-o'clock population as a control site for comparison with more disturbed populations elsewhere.
c. Apply adaptive management to achieve the best management practices for the species, for example, allowing moderate disturbance.

8.3 Fort Carson Natural Resources Management

Fort Carson has a well established system for managing its range lands. They have an updated Integrated Resource Management Plan (INRMP) and an Integrated Training Area Management program (ITAM) that address management of vegetation, soils, wildlife and endangered species. The Directorate of Environmental Compliance and Management (DECAM) has professional U. S. Fish and Wildlife Service (USFWS) Biologists on staff. Habitat for seven rare plant species has been surveyed and mapped as part of the Land Condition Trend Analysis (LCTA) program. They have sophisticated systems for photographing and geographic information systems for mapping species and habitat locations on the range. Their range conservation program includes mitigation and remediation for maneuver damage control. ITAM's Limited Use Program employs a land block rest-rotation method to allow training areas to recover after heavy use by armored vehicles.

8.4 Fort Carson Training Areas

Much of the chalk barrens habitat on Fort Carson is used for training in mechanized maneuvers. Some of it has steep slopes that are not used by vehicles. Other barrens sites are only used for recreation and/or grazing. Field research to date indicates that round-leaf four-o'clock, Pueblo goldenweed and golden blazing star are adapted to conditions that are unfavorable to most species. These barrens-adapted plants exhibit opportunistic growth patterns under conditions of moderate ground disturbance and nutrient-poor soils. They can be destroyed by frequently repeated impacts such as motor vehicle traffic.

8.4.1 Recommended Management on Training Areas

a. Conduct a complete inventory and assessment of chalk barrens habitat and round-leaf four-o'clock populations on Fort Carson. Share the data with CNHP for range-wide analysis.
b. Integrate species at risk management into the existing programs for protecting natural resources.
c. Ensure that range remediation methods are consistent with species at risk management
d. Maintain existing management of high quality round-leaf four-o'clock populations on the range.
e. Monitor the round-leaf four-o'clock population on disturbed sites for comparison with less disturbed populations elsewhere on the range.
f. Note non-native species in any monitoring visits. Develop and implement integrated weed management plans if non-natives become invasive.
g. Use the results of monitoring to apply adaptive management to achieve the best management practices for the species, e.g., prescribing moderate disturbance, or avoiding heavy disturbance during the flowering and seed production season in the months of June and July.

9 MEASURING EFFECTIVENESS OF CONSERVATION ACTIONS

9.1 Habitat Protection Goals, Objectives and Criteria Range-Wide

The goal for round-leaf four-o'clock is sufficient protection and viability of populations to preclude the need to list the species. The objective is to protect viable populations throughout a significant portion of the species' historic range.

Protection requires long-term conservation easements or management plans that designate specific enforceable actions. Each site will be managed to maintain the piñon/juniper chalk barrens habitat. Scientific monitoring data must indicate stable or increasing populations and provide the basis for sustainable management practices.

9.2 Colorado Natural Heritage Program Conservation Strategy

CNHP is Colorado's primary comprehensive biological diversity data center, gathering information and field observations to help develop statewide conservation priorities. Concentrating on site-specific data for each "element", such as a plant species, enables CNHP to evaluate the biological significance of each location where it is found. Priorities can then be established to guide conservation action. A continually updated locational database and priority-setting system such as that maintained by CNHP provides an effective, proactive land planning tool.

The habitat conservation strategy recommended by the CNHP is to maintain or enhance the current status of the eleven highest ranked populations of round-leaf four-o'clock, based on CNHP ranking criteria. The following sections describe the CNHP methods for prioritizing populations and protection status. Section 11 presents the monitoring program recommended for round-leaf four-o'clock by the CNHP.

9.3 Recovery Goals

The following recovery goals rely heavily on the information from CNHP's biological conservation database that includes information from published and unpublished sources (CNHP 2004). These data have at least three attributes that have an impact on the recovery goals. First, the entire potential habitat has not been surveyed; secondly, many of the known occurrences have not been thoroughly surveyed; and thirdly, the last observation date for 16 (55%) of the occurrences is 1995 or earlier.

Although the entire potential habitat has not been surveyed, it is important to note that much of the unsurveyed habitat for round-leaf four-o'clock is on private lands and subject to development pressures. For example, the Penrose area has numerous acres of potential habitat, but a high rate of development is present and for the most part, the habitat has been destroyed.

Geological maps combined with aerial photographs have been used to determine potential habitat, thus targeting surveys towards the most suitable habitat. Surveys have been conducted by numerous entities and most of this information has been synthesized by CNHP and placed into their conservation database. These surveys have documented approximately 7,300 individuals on 3,436 acres (CNHP 2004).

Note: The term individuals is extremely hard to apply to Oxybaphus rotundifolius, in that it is highly rhizomatous and thus clumps or stems that appear to be separate from another clump, may in fact be connected by an underground rhizome. In general, the term "individuals" refers to the identification of distinct "clumps."

9.4 Element Occurrence Ranking (CNHP 2004)

Actual locations of elements, whether they are single organisms, populations, or plant communities, are referred to as element occurrences. The element occurrence is considered the most fundamental unit of conservation interest and is at the heart of the Natural Heritage Methodology. In order to prioritize element occurrences for a given species, an element occurrence rank (EO-Rank) is assigned according to the estimated viability or probability of persistence (whenever sufficient information is available). This ranking system is designed to indicate which occurrences are the healthiest and ecologically the most viable, thus focusing conservation efforts where they will be most successful.

9.4.1 EO Ranking Criteria

The EO-Rank is based on 3 factors:

1. Size: a quantitative measure of the area and/or abundance of an occurrence such as area of occupancy, population abundance, population density, or population fluctuation.
2. Condition: an integrated measure of the quality of biotic and abiotic factors, structures, and processes within the occurrence, and the degree to which they affect the continued

existence of the occurrence. Components may include reproduction and health, development/maturity for communities, ecological processes, species composition and structure, and abiotic physical or chemical factors.

3. Landscape Context: an integrated measure of the quality of biotic and abiotic factors, and processes surrounding the occurrence, and the degree to which they affect the continued existence of the occurrence. Components may include landscape structure and extent, genetic connectivity, and condition of the surrounding landscape.

9.4.2 EO Ranking descriptions

Each of these factors is rated on a scale of A through D, with A representing an excellent grade and D representing a poor grade. These grades are then considered to determine an appropriate EO-Rank for the occurrence. If there is insufficient information available to rank an element occurrence, an EO-Rank is not assigned. Possible EO-Ranks and their appropriate definitions are as follows:

A Excellent estimated viability.
B Good estimated viability.
C Fair estimated viability.
D Poor estimated viability.
E Viability has not been assessed.
H Historically known, but not verified for an extended period of time
X Extirpated

Table 2. CNHP ranks for 29 Occurrences of round-leaf four-o'clock

Occurrence Rank and (number of occurrences)	Acres	Percentage of total acres
A (4)	797	23%
B (7)	841	25%
C (10)	184	5%
D (3)	6	<1%
E (4)	1,077	32%
H (1)	500	15%

Generally speaking, occurrences that have been ranked excellent to good are considered the most likely to survive with the least amount of restoration input. Four occurrences were ranked extant (E). Determining the viability of the extant occurrences may help with the overall assessment of round-leaf four-o'clock.

CNHP has 29 occurrences of round-leaf four-o'clock documented in their biological conservation database. Of these 29 occurrences, 11 occurrences have been ranked Excellent (A) to Good (B), representing approximately 48% of the occupied acres (Tables 2 and 3).

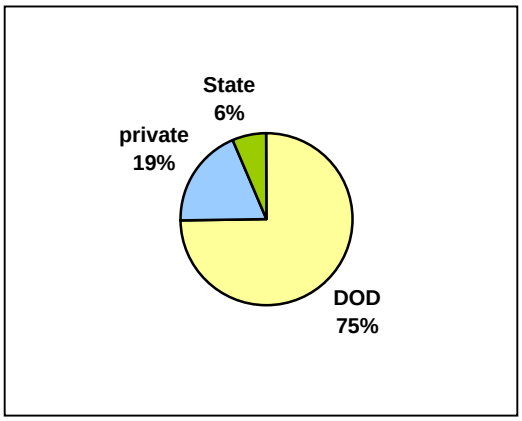
9.4.3 EO Ranking Specifications

CNHP's specifications for an "A" ranked occurrence of round-leaf four-o'clock are:
Size: 500 or more individuals.

Condition: the occurrence has an excellent likelihood of long-term viability as evidenced by the presence of multiple age classes and evidence of flowering and fruiting, indicating that the reproductive mechanisms are intact. This occurrence should be in a high-quality site with less than 1% cover exotic plant species and/or no significant anthropogenic disturbance.
Landscape Context: the occurrence is surrounded by an area that is unfragmented and includes the ecological processes needed to sustain this species. Justification: Large populations in high quality sites are presumed to contain a high degree of genetic variability, have a low susceptibility to the effects of inbreeding depression, and to be relatively resilient.

For rare species, such as round-leaf four-o'clock, it is especially important to concentrate *primary* conservation efforts on A-B ranked occurrences. CNHP has documented that most of these occurrences are on Department of Defense properties (Figure 10).

Figure 10. Ownership status of 11 highest ranked (A and B) occurrences of round-leaf four-o'clock (CNHP 2004).



Most of these A-B ranked occurrences on DOD lands were documented in 1995 and the current status is unknown, although believed to be similar. The need to update these occurrence ranks is high.

Nineteen percent (310 acres), of all known occupied acres for the high quality occurrences occur on private lands. Although a conservation easement is very likely for one of these occurrences and would include approximately 150 acres of occupied habitat, the other private land occurrences are not afforded any protection and have a high potential for development of some kind due to the proximity to a large urban growth area.

Table 3. Occurrences ranked A and B in CNHP's biological conservation database. The occurrence number refers to the CNHP's database reference number. Although there are six occurrences on private lands, most of the acres are on Department of Defense property. Occurrence No. 23 was found on both private and Department of Defense Lands.

Occurrence Number	Last Observed	Ownership	Acres	EORANK	Estimated No. of individuals
20	1995	DOD	365	B	>500
32	1995	DOD	203	B	250
31	1996	DOD	127	B	>84
24	1995	DOD	253	A	NA
23	2001	DOD	278	A	>500
23	2001	private	152	A	NA
8	1995	private	12	A	1000's
2	1998	private	63	B	300
10	1995	private	72	B	300
9	1995	private	5	B	500
6	2003	private	6	B	300
19	2003	State	103	A	1000

9.5 Protected Areas

Approximately 38% of the known occupied habitat is on federal or state lands (Figure 7), yet protection of the occurrences are not a given. For example, two of the largest occurrences are at Pueblo Reservoir State Recreation Area and Pueblo Reservoir State Wildlife Area, yet these occurrences are threatened by potential enlargement of the reservoir and expansion of the campground. The DOD occurrences are afforded some protection from direct development, however there is not an official adaptive management plan in place.

Round-leaf four-o'clock is included in The Nature Conservancy's ecoregional conservation plans for the Central Shortgrass Prairie and Southern Rocky Mountains ecoregion. TNC's goals for G1 and G2 elements are to include all occurrences within the conservation blueprint plan, thus noting the importance of managing the entire population. With round-leaf four-o'clock, it is highly unlikely that all known occurrences will be managed, as many occurrences are subject to road widening, housing development, mining, motocross courses, and potential flooding. For example one occurrence is already under the Pueblo West development and although the species is still present within the subdivision, the occurrence has been greatly altered.

One of the most reasonable assumptions for a conservation plan for round-leaf four-o'clock is the inclusion of all of the best and most viable occurrences (A and B-ranked). If this could be adequately completed, 48% of the known occupied acres would be protected and managed. It seems highly unlikely that all A-ranked occurrences could be protected given

that several are on private land and subject to development pressures. Thus one potential plan that could maintain this species would be to manage all of the public land (federal and state) acreage as well as acquire conservation easements or acquisition of the best populations known from private land.

"Protection" of round-leaf four-o'clock does not imply "no-use" for any given occurrence, but rather that adequate monitoring plans are in place to ensure an adaptive management approach. Kelso et al. (2003) found that round-leaf four-o'clock is a disturbance-tolerant species and its presence may be enhanced when disturbance inhibits the presence of other species that compete for limited water resources. Floristic comparisons of plots with low and high levels of disturbance showed that disturbance does not significantly decrease the presence of round-leaf four-o'clock, which occurred in 9 of 13 low-disturbance plots and 12 of 16 high-disturbance plots. Round-leaf four-o'clock stems were typically abundant on the disturbed plots (Kelso et al. 2003). An adaptive management plan will help to ensure the persistence of this species and provide important information on the impacts of different management scenarios that may differ by their disturbance regimes.

10 ADAPTIVE MANAGEMENT AND MONITORING

10.1 Monitoring Recommendations

An essential purpose of monitoring is to measure management success as well as raise an early warning flag that the trends may warrant a change in management (Elzinga et al. 1998). Good monitoring can demonstrate that the current management approach is working and provide evidence supporting the continuation of current management.

Elzinga states that monitoring is driven by objectives. Objectives form the foundation of the entire monitoring project and monitoring is only initiated if opportunities for management change exist. Monitoring also can measure overall trends for a given species that may help determine the rare and imperilment status.

If the primary objective/goal for round-leaf four-o'clock is to maintain all A-B ranked occurrences, a monitoring plan should be developed that can adequately assess these occurrences and document trends over a given time period. There are currently 11 known occurrences that could benefit from monitoring (Table 3).

Heckmann (1997) makes recommendations for methods of tracking individual round-leaf four-o'clock plants during monitoring: establish a minimum distance between plants that are counted as distinct individuals, mark and monitor the same individuals throughout the season and in subsequent years to document dormancy, and establish a consistent method for recording reproductive structures.

10.2 Monitoring Design

Monitoring can be an expensive endeavor but it is also possible to develop a monitoring plan that is efficient, meets objectives, and is cost-effective. A two-phased approach to monitoring round-leaf four-o'clock is presented, with the first phase providing the most cost-efficient method but less detailed, while the second phase provides a detailed approach, but may be more costly. The two types of monitoring are: 1) Rapid occurrence assessment, and 2) Detailed occurrence assessment. These are outlined below.

10.2.1 Rapid Occurrence Assessment

This type of monitoring is a "quick" assessment of an occurrence that requires applying element occurrence rank specifications. The primary criteria for assessments are size, condition, and landscape context. The current specifications that CNHP have developed would need slight modifications to ensure a consistent way of counting plants. The time needed to assess an occurrence will depend on the size of the occurrence, but in general, most occurrences could be adequately assessed in a one to two day site visit. All of the existing highest quality occurrences could be visited in approximately two to four weeks. Thus the objective of maintaining all A-B ranked occurrences could easily be assessed in a timely manner.

For all monitoring plans, it is important to recognize life history strategies that may impact the results of monitoring. Round-leaf four-o'clock individuals and occurrences are subject to periodic droughts and often respond by going dormant for the season, thus the above ground parts are not visible (Heckman 1997). Surveys and monitoring during drought years will inevitably miss the dormant plants and underestimate the population. We recommend that the rapid occurrence assessments be conducted only in non-drought years to ensure a more consistent assessment.

10.2.2 Detailed Occurrence Assessment

This type of monitoring should include a more detailed monitoring plan for several of the occurrences. Ideally, these sites would include permanent monitoring plots, thus it would be best to pick sites that are likely to remain intact. Kelso et al. (2003) observed that round-leaf four-o'clock is tolerant of disturbance and that some occurrences have done well in sites disturbed by military training and grazing. However, other occurrences have been extirpated due to an excessive amount of disturbance. Since the DOD properties include an important part of round-leaf four-o'clock occurrences and also include the full range of potential disturbance regimes, there is strong potential for an effective monitoring design.

Measuring plant performance under differing disturbance regimes is most likely to generate data that can support appropriate management decisions for this species. One approach would be to address management needs by monitoring several sites with varying disturbance regimes. Ideally, plots would be selected that include examples of the spectrum of anthropogenic and natural disturbance regimes that can affect round-leaf four-o'clock. Measuring readily observable variables such as density of ramets and vigor (by measuring ramet height, leaf size, number of leaves, or other attributes) at the permanent plots could provide insight into the tolerance threshold of round-leaf four-o'clock to different disturbance regimes. Measuring other biotic variables such as plant cover, and abiotic variables such as soil porosity and compaction could provide insight into ecological reasons behind any observed changes.

The design and implementation of a detailed occurrence assessment will largely depend on developing management and sampling objectives, which must be determined a priori.

10.3 Monitoring Schedule

It will be very important to develop an adequate monitoring plan that is statistically valid. Monitoring rhizomatous perennials such as round-leaf four-o'clock that exhibit prolonged dormancy presents special challenges, and obtaining meaningful data may require large sample sizes and several years.

Normally, the first year of a monitoring plan would be considered a pilot project that will allow the botanist to work out the best protocol and estimate the correct sample size for the following years. In subsequent years return visits would be conducted during phenologically appropriate times to resample plots. At first, monitoring should be conducted annually, and this should continue unless it is determined that responses to disturbance and other variables can be measured with less frequent plot resampling. Results would be reported and analyzed annually.

11 FEASIBILITY AND TIMETABLE

11.1 Monitoring

CNHP estimates that a rapid assessment of the eleven existing highest quality occurrences could be completed in approximately two to four weeks. Thus the objective of maintaining all A-B ranked occurrences could easily be assessed in a timely manner.

The approximate budget for CNHP professional staff to conduct the 11 field assessments, enter results into their conservation data system and write an annual report would be $18,800. Planning for the project could start in 2004. Monitoring could start in 2005, assuming it is not a drought year.

Planning for the first year of detailed monitoring could follow a similar schedule. Funding would depend on the plan and the researchers available.

11.2 Conservation Easements

Arrangements to secure a potential conservation easement adjacent to Fort Carson are continuing at this time.

12 INFORMATION MANAGEMENT

12.1 Colorado Natural Heritage Program Data Synthesis and Analysis

"Information on species and ecological communities is first compiled from existing sources, such as scientific literature, field guides, and museum collections. Natural heritage biologists conduct extensive field inventories to locate and verify species populations and to assess their current conservation condition. Each program maintains and continuously updates a sophisticated computer database that tracks the relative rarity of each species or community and the precise location and status of each known population. Representing more than 25 years of continuous ecological inventory and database development, these are the most complete and up-to-date conservation databases available." (CNHP 2004)

12.2 Disclaimer (CNHP 2004)

The following disclaimer applies to the map on page 15 and all other data in this document that are credited to the CNHP Biodiversity Tracking and Conservation System.

Care should be taken in interpreting these data. The information provided should not replace field studies necessary for more localized planning efforts. Please note that the absence of any data does not mean that other resources of special concern do not occur, but rather our files do not currently contain information to document this presence. Data are provided on an as-is, as-available basis without warranties of any kind, expressed or implied, including (but not limited to) warranties of merchantability, fitness for a particular purpose, and non-infringement. CNHP, Colorado State University and the State of Colorado further expressly disclaim any warranty that the data are error-free or current as of the date supplied.

13 REFERENCES CITED

Anderson, David G. 2003. Species Assessment for Golden Blazing Star (*Mentzelia Chrysantha*). Unpublished report prepared for the USDA Forest Service, Region 2 by the Colorado Natural Heritage Program, Fort Collins, Colorado

Colorado Division of Wildlife, Habitat Resources Section. 1998. Colorado Gap Analysis Land Status Map. Denver, Colorado.

Colorado Natural Heritage Program. 2004. Biodiversity Tracking and Conservation System. Colorado State University, Fort Collins, Colorado.

Directorate of Environmental Compliance and Management (DECAM). 2004. Occurrence data provided to the Colorado Natural Heritage Program for *Oxybaphus rotundifolius* on Fort Carson Military Reservation and U.S. Army Piñon Canyon Maneuver Site, Colorado.

Elzinga, C. L., Salzer, D.W., and J.W. Willoughby. 1998. Measuring and monitoring plant populations. BLM Technical Reference 1730-1. Denver, Colorado: U.S.D.I. Bureau of Land Management, 492 pp.

Gibson, A.C., M. Rasoul Sharifi, and P.W. Rundel. 1998. Effects of Military Activities and Dust on Creosote Bushes. Twenty-Third Annual Meeting and Symposium of the Desert Tortoise Council, Abstracts.

Grunau, L., A. K. Ruggles, M. Venner, C. Pague, R. Rondeau, and J. M. Powell. 2003. Programmatic Biological Assessment, Conference Report, and Conservation Strategy for Impacts from Transportation Improvement Projects on Select Sensitive Species on Colorado's Central Shortgrass Prairie. Unpublished report prepared for the U.S. Fish and Wildlife Service.

Grunau, L. and A. Lavender. 2002. Estimating Impacts of Highway Projects on Select Rare, Sensitive, or Declining Species on Colorado's Central Shortgrass Prairie. Unpublished report

prepared for the Colorado Department of Transportation by the Colorado Natural Heritage Program, Fort Collins, Colorado
Heckmann, K. 1997. The Ecology and Distribution of *Oxybaphus rotundifolius*. Senior thesis submitted to the Department of Biology, Colorado College, Colorado Springs.

Kelso, S., N.W. Bower, K.E. Heckman, P.M. Beardsley, and D.G. Greve. 2003. Geobotany of the Niobrara Chalk Barrens in Colorado: a Study of Edaphic Endemism. Western North American Naturalist 63(3):299-313.

Kelso, S., C. Hall, and G. Maentz. 2001. The Role of Landscape Anomalies in Regional Plant Conservation. Proceedings of the 3rd Southwestern Rare Plant Conference, Flagstaff, Arizona. Pages 13-19 in J. Maschinski and L. Holter, editors, USDA Forest Service, Rocky Mountain Research Station Proceedings RMRS-P-23.

Kelso, S., K. Heckman, J. Lawton, and G. Maentz. 1996. Endemic Calciphiles of the Middle Arkansas Valley, Colorado. Proceedings of the 2nd Southwestern Rare Plant Conference, Flagstaff, Arizona. Pages 270-280 in J. Maschinski et. al., editors, USDA Forest Service, General Technical Report RM-GTR-283.

Kelso, S., K. Heckmann, J. Lawton, and G. Maentz. 1995. The Ecology and Distribution of *Oxybaphus rotundifolius* and *Penstemon versicolor*: Geobotany and Endemism in the Arkansas Valley, Colorado. Department of Biology, Colorado College, Colorado Springs. Report to the Colorado Natural Areas Program and Colorado Native Plant Society. 30 pp. + appendices.

Naumann, T. 1990. Status Report for *Oxybaphus rotundifolius*. Unpublished report produced for the U.S. Fish and Wildlife Service by the Colorado Natural Areas Program.

Spackman-Panjabi, S., J. Sovell, G. Doyle, D. Culver, and L. Grunau. 2003. Survey of Critical Biological Resources of Pueblo County, Colorado. Fort Collins, Colorado: Unpublished report prepared for the Pueblo County Planning Department by the Colorado Natural Heritage Program,

Spackman, S., B. Jennings, J. Coles, C. Dawson, M. Minton, A. Kratz, and C. Spurrier. 1997. Colorado Rare Plant Field Guide. Prepared for the Bureau of Land Management, the U.S. Forest Service and the U.S. Fish and Wildlife Service by the Colorado Natural Heritage Program, Fort Collins, Colorado.

Spackman, S., and S. Floyd. 1996. Conserving the Globally Imperiled Plants of the Middle Arkansas Valley, Colorado. Prepared for The Nature Conservancy by the Colorado Natural Heritage Program, Colorado State University, Fort Collins, Colorado.

Spackman Panjabi, S.C. 2004. Visiting Insect Diversity and Visitation Rates for Seven Globally-Imperiled Plant Species in Colorado's Middle Arkansas Valley. Prepared for the Native Plant Conservation Alliance and the National Fish and Wildlife Foundation by the Colorado Natural Heritage Program, Colorado State University, Fort Collins, Colorado.

The Nature Conservancy. 2001. Arkansas Valley Barrens Site Conservation Plan. Boulder, Colorado.

14 ADDITIONAL REFERNCES

Anderson, D., P. Lyon, S. Spackman, and J. Handwerk. 2001. Weed and Rare Plant Assessments on Selected BLM ACECs. Unpublished report prepared for the Bureau of Land Management by the Colorado Natural Heritage Program.

Bureau of Land Management. 2000. Colorado BLM State Director's Sensitive Species List. Accessed via the internet at http://www.co.blm.gov/botany/sensspecies.htm .

Doyle, G., J. Armstrong, J. Gionfriddo, D. Anderson, J. Stevens, and R. A. Schorr. 2001. Survey of Critical Biological Resources, El Paso County, Colorado. Unpublished report prepared for El Paso County Parks and Leisure Services by the Colorado Natural Heritage Program.

Center for Plant Conservation. 2003. National Collection of Endangered Plants. Accessed via the internet at: http://ridgwaydb.mobot.org/cpcweb/CPC_NCList_Find.asp. Missouri Botanical Garden.

Potter, L.D., R.C. Reynolds, and E.T. Louderbough. 1985. Mancos shale and plant community relationships: Field observations. Journal of Arid Environments 9: 137-145.

Shaw, R.B., S.L. Anderson, K.A. Schulz, V.E. Diersing. 1989. Plant Communities, Ecological Checklist, and species List for the U.S. Army Piñon Canyon Maneuver Site, Colorado. Colorado State University Department of Range Science, Science Series No. 37.

15 CONTACTS

Colorado Natural Heritage Program
- David Anderson, Botanist
- Jill Handwerk, Botanical Data Manager
- Renee Rondeau, Director
- Susan C. Spackman Panjabi, Botanist

The Nature Conservancy, Boulder Colorado
- Matt Moorhead
- Betsy Neely
- Steve Kettler

Colorado College: Sylvia Kelso, Ph.D.

Directorate of Environmental Compliance and Management, Fort Carson
- Caron Rifici
- Richard Bunn

Piñon Cañon Maneuver Site: Dan Sharp

U.S. Forest Service, Pueblo Colorado: Steve Olson

Island Fox

Management Guidelines for Species at Risk on Department of Defense Installations

NatureServe

NatureServe is a non-profit organization that provides
the scientific basis for effective conservation.

Citation:

Vissman, S. 2004. *Island Fox: Management Guidelines for Species at Risk on Department of Defense Installations.* NatureServe, Arlington, Virginia.

This work was made possible with funding from the U.S. Department of Defense and the U.S. Fish and Wildlife Service.

Front cover photo: Island fox (*Urocyon littoralis*).

NatureServe
1101 Wilson Boulevard, 15th Floor
Arlington, VA 22209
703-908-1800
www.natureserve.org

Author's Contact Information:
Sandy Vissman
San Clemente Island Coordinator
U.S. Fish and Wildlife Service
Carlsbad Fish and Wildlife Office
6010 Hidden Valley Road
Carlsbad, California 92009
(760) 431-9440 / (760) 431-5901
Sandy_Vissman@fws.gov

ISLAND FOX

MANAGEMENT GUIDELINES FOR SPECIES AT RISK ON DEPARTMENT OF DEFENSE INSTALLATIONS

SAN CLEMENTE ISLAND AND SAN NICOLAS ISLAND CALIFORNIA

Sandy Vissman

April 2004

NatureServe
A Network Connecting Science With Conservation

Table of Contents

Executive Summary 1
1. Species Identifiers 2
2. Contacts 2
3. Species Range, Status, and Life History 3
4. Habitat Requirements 5
5. Threats to the Species 8
6. Regional Conservation Actions 8
7. DoD Conservation Actions 8
8. Measuring Effectiveness of Conservation Actions 17
9. Literature Cited 20

Figure 1. Management units and fox grids on San Clemente Island. 6
Figure 2. Fox monitoring grids on San Nicolas Island. 7

Table 1. Adaptive management approach for San Clemente Island Fox. 14
Table 2. San Clemente Island: Conservation actions, expertise needed, projected cost ($) and projected year of implementation. 18
Table 3. San Nicolas Island: Conservation actions, expertise needed, projected cost and projected year of implementation 18

Executive Summary

The island fox (*Urocyon littoralis*) is endemic to six of the eight California Channel Islands and is the largest native land mammal on these islands. In addition to being the smallest fox species in the United States, it is the only mid-sized mammal unique to California, and California's only endemic carnivore (Juola *et al*. 2002). The island fox is currently classified as threatened by the state of California (California Department of Fish and Game 1987), and four fox subspecies were classified as endangered by the U.S. Fish and Wildlife Service in 2004 (69 FR 10353).

The island fox occurs on two Department of Defense (DOD) installations in the Pacific Ocean: San Clemente Island (*Urocyon littoralis clementae*) and San Nicolas Island (*Urocyon littoralis dickeyi*). A unique subspecies is found on each island, although the subspecies share similar traits and biology. Both subspecies are of concern to Department of Defense as closely related subspecies on nearby islands have experienced precipitous declines in the past six years. The only two subspecies of island fox that have not dramatically declined and been placed on the Endangered Species list are the two subspecies addressed by these Species at Risk Guidelines (SAR Guidelines).

The overall Conservation Objective of this guidance document is to maintain stable or increasing island fox populations that are large enough to reduce extinction risk on San Clemente and San Nicolas Islands. To accomplish this conservation objective, the guidelines describe a plan to effectively monitor the population and implement adaptive management actions if the population declines to pre-determined levels. Using these guidelines, DOD would:

(1) use population modeling techniques combined with understanding of the species demography and historical population size to determine a population size necessary to reduce extinction risk;
(2) monitor the demography and health of island fox populations on DOD installations;
(3) incorporate island fox conservation needs into facilities and range planning;
(4) implement measures to reduce the potential for population declines by removing or minimizing mortality factors and stressors;
(5) identify the magnitude of population decline (or catastrophic event) that would warrant increased monitoring or remedial action; and
(6) identify response mechanisms to be taken if population decline does occur.

The island fox has been identified in Integrated Natural Resource Management Plans for both San Clemente Island and San Nicolas Island. Management Guidelines identified in this document may be incorporated into future revisions of the INRMPs.

1. Species Identifiers

Scientific Name: *Urocyon littoralis*
Common Name: Island fox
Department of Defense Installation(s) where species occurs:
San Clemente Island and San Nicolas Island

2. Contacts

Department of Defense Contacts:

Kelly Brock, San Clemente Island
San Clemente Loggerhead Shrike Program Coordinator
Commander Navy Region Southwest
Bldg 50 Nixie Way
San Diego, California 92106
(619) 524-6362
Kelly.brock@navy.mil

Grace Smith, San Nicolas Island
Ecologist
NAWCWD Code 52F000E
575 "I" Avenue, Suite I
Point Mugu, CA 93042-5049
(805) 989-3807
smithgg@navair.navy.mil or grace.smith@navy.mil

U.S. Fish and Wildlife Service (USFWS) Contact:

Sandy Vissman (Primary Author of Guidelines Document)
San Clemente Island Coordinator
Carlsbad Fish and Wildlife Office
6010 Hidden Valley Road
Carlsbad, California 92009
(760) 431-9440
(760) 431-5901
Sandy_Vissman@fws.gov

Authorities

The authorities for the conservation are derived from the following statutes and regulations:
Endangered Species Act of 1973 (16 U.S.C. *et seq*.)
Sikes Act Improvement Act of 1977 (Public Law 105-85: 16 U.S.C. 670a *et seq*.)

Department of Defense Directive 4715.1 (Environmental Security)
Environmental and Natural Resources Program Manual (OPNAVINST 5090.1B CH-2)

Partners
Department of Defense will be using the guidelines described herein in partnership with the U.S. Fish and Wildlife Service, California Department of Fish and Game, non-profit wildlife and research organizations, and universities.

3. Species Range, Status, and Life History

The island fox (*Urocyon littoralis*), inhabits the six largest Channel Islands off the California coast. Each island (Santa Catalina, San Miguel, Santa Cruz, Santa Rosa, San Nicolas, and San Clemente) supports a unique subspecies of island fox. The species is listed as "threatened" by the State of California. Four of the six island subspecies (San Miguel Island fox, Santa Cruz Island fox, Santa Catalina Island fox, and Santa Rosa Island fox) have recently experienced catastrophic population declines and were listed as Endangered under the Endangered Species Act on March 5, 2004 (69 FR 10353).

Although island fox subspecies that inhabit DOD lands on San Clemente Island and San Nicolas Island have not experienced the dramatic declines observed in the northern Channel Islands, these subspecies may be vulnerable to future declines due to the small size of the populations, potential for exposure to canine diseases, potential for vehicle collision, and possible sensitivity to habitat changes, disturbances, competition, and wildlife management. In summer, 2004, the San Clemente Island subspecies represents approximately 45 percent and the San Nicolas subspecies approximately 31 percent of the existing *Urocyon littoralis* population (Dave Garcelon, pers. Comm. 2004). DOD lands, therefore support approximately 76 percent of the island fox species, as well as each supporting a unique subspecies. The management guidelines found within this document are intended to reduce potential threats to the island fox subspecies on San Clemente Island (*Urocyon littoralis clementae*) and San Nicolas Island (*Urocyon littoralis dickeyi*).

Island Fox Biology

Island foxes are omnivores, taking a wide variety of seasonally available plants and animals (Collins and Laughrin 1979; Collins 1980; Kovach and Dow 1981; Moore and Collins 1995; Crowell 2001). Island foxes forage opportunistically on any food items encountered within their home range. Diet is determined largely by availability, which varies by habitat and island, as well as seasonally and annually. Island foxes prey on native deer mice (*Peromyscus maniculatus*) and harvest mice (*Reithrodontomys megalotis catalinae*), as well as introduced house mice (*Mus musculus*) and rats (*Rattus rattus* and *R. norvegicus*). Small mammals may be especially important prey during the breeding season, because they are large, energy-rich food items that adult foxes can bring back to their growing pups (Garcelon *et al*. 1999). In addition to small mammals, island foxes feed on ground-nesting birds such as horned larks (*Eremophila alpestris*), Catalina quail (*Callipepla californica catalinensis*) and western meadowlarks (*Sturnella neglecta*), and a wide variety of insect prey (Moore and Collins 1995). At certain

times of the year, foxes feed heavily on orthopterans (e.g., grasshoppers and crickets) (Crooks and VanVuren 1995), especially Jerusalem crickets (*Stenopelmatus fuscus*). Less common in the diet are amphibians, reptiles, and carrion of marine mammals (Collins and Laughrin 1979). Island foxes feed on a wide variety of native plants, including the fruits of manzanita (*Arctostaphylos* spp.), summer holly (*Comarostaphylis* spp.), toyon (*Heteromeles arbutifolia*), cactus (*Opuntia* spp.), island cherry (*Prunus ilicifolia*), sumac (*Rhus* spp.), rose (*Rosa* spp.), nightshade (*Solanum* spp.), and huckleberry (*Vaccinium* spp.) (Moore and Collins 1995).

The island fox is docile and shows little fear of humans in many instances. Although primarily nocturnal, the island fox is more diurnal than the mainland gray fox (Collins and Laughrin 1979; Fausett 1993). Diurnal activity is thought to be a result of the historical absence of large predators and freedom from human harassment on the islands (Laughrin 1977).

Mated island foxes maintain territories that are separate from the territories of other pairs (Crooks and Van Vuren 1996; Roemer *et al*. 2001a). Island fox home range size varies with sex, season, population density, landscape features, and habitat type (Laughrin 1977; Crooks and Van Vuren 1996; Thompson *et al*.1998; Roemer *et al*. 2001a). Estimates of territory size range from 0.24 square kilometer (km^2) (59 acres (ac)) in mixed habitat (Crooks and Van Vuren 1996) and 0.87 km^2 (214 ac) in grassland habitat (Roemer 1999) on Santa Cruz Island, to 0.77 km^2 (190 ac) in canyons on San Clemente Island (Thompson *et al*. 1998). Island fox territory configuration changes after the death and replacement of paired male foxes, but not after the death and replacement of paired females or juveniles, indicating that adult males are involved in territory formation and maintenance (Roemer *et al*. 2001a).

Although island foxes appear monogamous, copulations with individuals other than the mate are common and often result in offspring. Courtship activities occur from late January to early March; genetic evidence suggests that inbreeding avoidance occurs (Roemer *et al*. 2001a). Recent endocrine assays on fecal samples from San Miguel Island indicate that, unlike all other canids studied to date, island foxes are induced rather than spontaneous ovulators (Bauman *et al*. 2001). Young are born from late April through May after a gestation period of approximately 50 days. Island foxes give birth to their young in simple dens, which are usually not excavated by the foxes themselves (Moore and Collins 1995). Any available sheltered site (e.g., brush pile, rock crevice, and hollow stump) may be used (Laughrin 1977). Litter size ranges from one to five pups (Moore and Collins 1995). Laughrin (1977) found an average litter of 2.17 for 24 dens on Santa Cruz Island; this estimate likely reflected the number of pups weaned rather than born. The average size of 35 litters born in captivity since 1999 is 2.3 (Coonan et al. in prep.). Both island fox parents care for the young (Garcelon *et al*. 1999). By 2 months of age, young foxes spend most of the day outside the den and will remain with their parents throughout the summer. Some pups disperse from their birth territories by winter, although others may stay on their natal territories into their second year (Coonan 2003a). Island foxes can mate at the end of their first year (Collins and Laughrin 1979), although most breeding involves older animals. Coonan *et al*. (1998) found that only 16 percent of females under the age of 2 bred over a 5-year period, in contrast to 60 percent of older females.

Due to the low reproductive output of island foxes, survival of adults is considered the most important factor influencing population growth rate (Roemer 1999; Roemer *et al*. 2001b, d).

Compared with the gray fox, island fox populations are skewed toward older adults (Laughrin 1980; Garcelon 1988). Adult island foxes live an average of 4 to 6 years (Moore and Collins 1995), although this may be an underestimate (Coonan *et al*. 1998). Island foxes may live 8 to 10 years in captivity or in the wild in the absence of catastrophic mortality forces (Tim Coonan, National Park Service, *in litt*. 2002).

Island foxes are approximately 0.3 meter (1 foot) tall and weigh approximately 1.4 to 2.7 kilograms (3 to 6 pounds). The base of the ears and sides of the neck and limbs are cinnamon-rufous in color, the back is grayish-white and black, and the underbelly is a dull white. Island foxes display sexual size dimorphism, with males larger and heavier than females (Moore and Collins 1995).

4. Habitat Requirements

The island fox is a habitat generalist, occurring in valley and foothill grasslands, southern coastal dunes, coastal bluff, coastal sage scrub, maritime cactus scrub, island chaparral, southern coastal oak woodland, southern riparian woodland, Bishop (Pinus muricata) and Torrey pine (Pinus torreyana) forests, and coastal marsh habitats. Although foxes can be found in a wide variety of habitats, they prefer areas of diverse topography and vegetation (Von Bloeker 1967; Laughrin 1977; Moore and Collins 1995). Laughrin (1973, 1980) found higher fox density in woodlands, while Crooks and Van Vuren (1995) found more island foxes in fennel grasslands. On San Clemente Island, higher fox densities have consistently been reported on grids located in Maritime Desert Scrub, lycium phase, than in non-native grasslands (Dave Garcelon, pers. Comm. 2004). Likewise, higher fox densities have been recorded in maritime dune communities on San Nicolas Island than in annual grasslands.

San Clemente Island

On San Clemente Island, foxes use all areas of the island, but higher densities are apparent in the northern part of the island, which is dominated by low vegetation including maritime desert scrub, *lycium* phase and in the southern part of the island, which is characterized by deeply incised, narrow canyons, canyon woodland surrounded by desert scrub and native grassland. The central island plateau, which is dominated by non-native grasslands, supports lower fox densities.

San Clemente Island has been divided into 18 Management Units as part of the Integrated Natural Resources Management Plan (Figure 1). These Management Units were designed primarily to address fire management requirements - the boundaries of individual units are primarily roads, canyon rims, or fuelbreaks, all of which are expected to slow spread of wild fire. In the San Clemente Island Integrated Natural Resources Management Plan (INRMP), the military value and ecological value of each management unit was assessed on a subjective scale, rating from lowest to highest, however relative importance to the island fox was not considered since island foxes inhabit all Management Units on San Clemente Island. Based on the techniques used for island-wide population estimation and the overall acreage and vegetation cover in each management area, a fox population estimate was derived for each of the

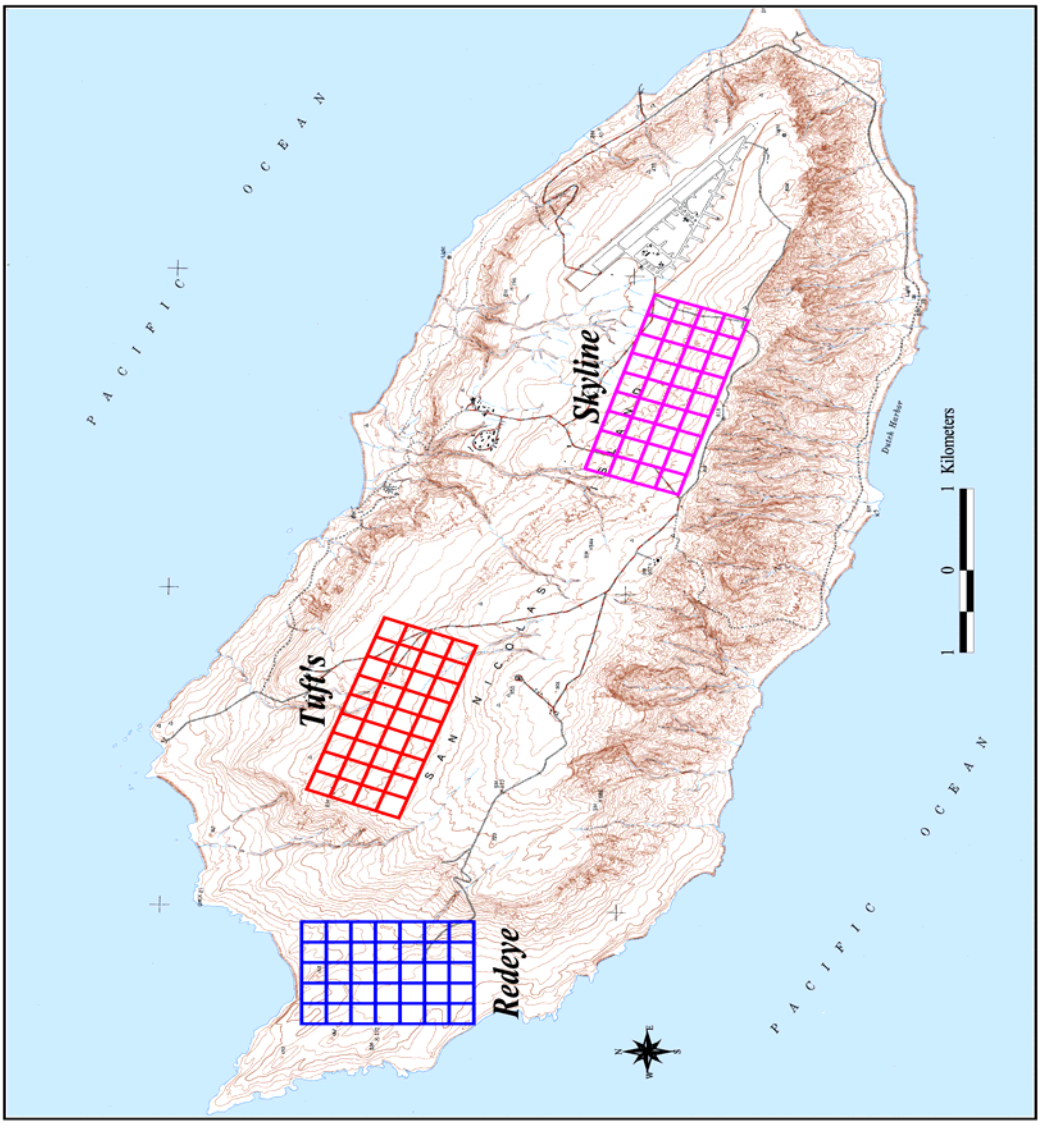
management units on SCI (Table 1). The fox density estimated for each vegetation type (Wolstenholme *et al*. 2003) was applied to the acreage of each plant community in each management unit to provide an estimate of the fox population size in each management unit. The fox population estimates for each management, therefore, are a function of the size of the management unit and the area recorded for each plant community rather than monitoring of each unit. Using this technique to estimate population size, the importance of maritime desert scrub communities stands out. Population estimates for each management unit may be used in future iterations of the INRMP to better address the importance of each management unit to the conservation of island fox on SCI.

Figure 1. Management units and fox grids on San Clemente Island.

San Nicolas Island

Island foxes occupy all San Nicolas Island habitat types, with densities being highest in areas of native vegetation and lowest in barren areas or those comprised primarily of non-native annual grasslands. Annual monitoring of the population is conducted to evaluate current demography and monitor changes in population parameters. Three capture-recapture sampling grids have been established overlaying several vegetation communities. The grids dominated by coastal scrub and inland dune habitats on the central and western portion of the island, support the highest densities of foxes. Fox population estimates for the entire island are developed by applying fox density values to each island vegetation type and extrapolating for the total area for each vegetation type.

Figure 2. Fox monitoring grids on San Nicolas Island.



5. Threats to the Species

On San Clemente Island and San Nicolas Island numerous stressors to the island fox population exist that have some potential to threaten the population in the future. Increasingly intensive use may adversely effect the fox population if habitat modification (loss to facilities, fires, and ranges), increasing levels of vehicle use, and increasing disturbances associated with noise, vibration, and human presence occur. In addition, disease, endangered species predator management activities, competition with feral cats, rodent control around facilities and unfavorable habitat changes from historical management practices may also affect foxes. On San Nicolas Island, the lack of genetic variation observed in the fox population has been noted as an additional point of concern. Genetically depauperate populations may be particularly vulnerable to disease epidemics (O'Brien and Everman 1988).

6. Regional Conservation Actions

The island fox subspecies found on San Clemente and San Nicolas Islands are endemic, and are found wholly on DOD owned and managed lands. No regional conservation actions are developed to protect these subspecies, because the subspecies do not occur throughout the region. However, extensive efforts aimed at preventing the extinction of the island fox subspecies on surrounding islands include: 1) predator management; 2) captive breeding and release; 3) translocation; 4) distemper vaccinations; 5) wild population monitoring; 6) public education.

7. DOD Conservation Actions

On San Clemente Island, the Navy has supported ongoing island fox monitoring and several island fox studies since 1988. In addition, the Navy and the Fish and Wildlife Service signed a Conservation Agreement to address and offset potential threats to the San Clemente island fox in 2003 (Appendix 1). The agreement outlined conservation actions that the Navy had begun to implement, and those for which they had sufficient funding to implement in the near future. Conservation measures identified in the conservation agreement include: 1) expanded cat control efforts intended to reduce cat numbers and thereby reduce competitive interactions between cats and foxes; 2) use of alternatives to box trapping for cat control to minimize incidental impacts to foxes; 3) discontinuation of fox management activities to protect shrikes to minimize impacts to the island fox; 4) modification of rodenticide bait boxes to reduce the potential for foxes to be exposed to rodenticide; 5) continuation of habitat augmentation by propagation and outplanting of native plants, and potential initiation of habitat augmentation through the use of controlled burns; 6) implementation of a 35 mph speed limit to reduce incidents of vehicle-fox collision; 7) installation of "watch out for foxes" signs and education of island personnel about the island fox; 8) maintenance of a clear shoulder on road edges to allow drivers to more easily see foxes along the road edge and reduce incidents of road kill; 9) consideration of impacts to island foxes for military activities proposed in the upcoming Environmental Impact Statement for SCI; 10) modification of monitoring to allow more

accurate assessment of fox population size and trend; 11) submission of fox carcasses to a wildlife pathologist to allow timely identification of disease issues and potential remedies; 12) establishment of a data base to allow ongoing documentation and quantification of road kills, and identification of remedial measures for spikes in road kill numbers. These Island Fox Management Guidelines incorporate measures identified in the Conservation Agreement (marked by an asterix *).

On San Nicolas Island, the Navy has supported study of island foxes since the 1980's, with consistent annual monitoring beginning in 2000. In addition, the Navy has implemented numerous measures to reduce human-caused impacts to island fox. These proactive protection measures include: 1) maintenance and enforcement of the 35 mph speed limit to reduce incidents of vehicle-fox collision; 2) installation of "watch out for foxes" signs in areas of high fox density; 3) education of island personnel about the island fox; 4) maintenance of a clear shoulder on road edges to allow drivers to more easily see foxes along the road edge and reduce incidents of road kill; 5) implementation of pest management practices that minimize harm to island fox; 6) restriction of rodenticides to avoid secondary poisoning of foxes; 7) modification of all refuse bins to exclude foxes and prevent injury during refuse transfer; 8) submission of fox carcasses to a wildlife pathologist to allow timely identification of disease issues and potential remedies; and 9) establishment of a data base to allow ongoing documentation and quantification of road kills.

The guidelines described below may be incorporated into future iterations of the INRMPs for San Clemente and San Nicolas Islands to address the future management and protection of the island fox on these installations.

I. Monitor the size and health of island fox populations on San Clemente Island.*

A. Assess the validity of the current population estimation techniques. Refine monitoring to allow determination of additional demographic variables. Fish and Wildlife Service biomonitor staff can contribute to review of current monitoring techniques and provide recommendations for any modifications that could improve precision of current estimates. Future implementation of intensified monitoring or other adaptive management actions is dependent upon accurate assessment of the island fox population size, growth, stability, and health.

*B. Continue to use grid trapping and density estimates to derive island fox population estimate during periods of non-catastrophic population fluctuation.**

1. Increase grid coverage to address fox densities in currently underrepresented habitat types.
2. Update vegetation maps to allow more accurate estimate of population size if densities will be extrapolated to plant community coverage for determination of population size.

C. Continue to use monthly spotlight fox counts to identify rapid changes in distribution and abundance of foxes on SCI and SNI.

D. Incorporate transects into monitoring efforts if lambda is less than .94 over two breeding seasons, as identified in the Adaptive Management section. Include at least one transect in each of the 18 Management Units on San Clemente Island. Increase the frequency of monitoring on the 3 transects currently run on San Nicolas Island, and increase the number of transects if transect monitoring becomes necessary. Collect blood samples from all trapped individuals and conduct serology investigation. Collect vital statistics and information about general condition for all foxes captured on transects.

E. Conduct necropsies on all recovered island fox carcasses. In cooperation with UC Davis pathologists, create a database that summarizes the results of all necropsies conducted to date on fox carcasses from SCI and SNI. Document the identification number of each fox (if known) and the recovery location of the carcass. Continue this database into the future.

II. Incorporate island fox conservation needs into facilities and range planning.

A. *To the extent possible, include affects to island foxes and mechanisms to minimize affects to island foxes in all NEPA documents. Determine the extent to which current and future shore installation activities, as well as range and training activities, overlap areas of importance to island fox reproduction, and avoid or minimize impacts when feasible and in accordance with no net loss to Navy readiness requirements. The core of the pupping season (March-June) is a particularly sensitive period for this species.* On SCI and SNI the training mission is of paramount importance. In some instances, long range planning may allow training or facilities construction projects to be conducted outside the pupping season. Little information is currently available about fox den distribution/use to allow avoidance of dens if surface disturbing projects are necessary during the pupping season, however avoidance of this time period is likely to contribute to fox reproductive success by avoiding the potential for den disturbance or modification during the most sensitive period.

B. *Identify key areas of importance to the fox population (i.e. population concentrations, areas of resource availability,) and protect these areas from disturbance as uses on-island intensify.* Based on density estimates derived from grid trapping, maritime desert scrub communities on SCI and SNI support the highest densities of island foxes and are therefore important to maintain. These communities are distributed primarily along the western third of SCI and in the central region of SNI. The SCI INRMP provides data regarding the vegetation coverage in each recognized management unit on the island. Based on the acreage of each management unit and MDS coverage, NAME THE MOST IMPORTANT MANAGEMENT UNITS HERE…..are extremely important units for island fox conservation.

C. *Incorporate measures to encourage reduced speeds of travel into new facilities and improvements on the island.* Island foxes appear prone to collision with vehicles due

to their behavior patterns, densities in the vicinities of roads on SCI and SNI, small stature, and coloration. Foxes are difficult to see if they are standing in roadside vegetation and sometimes run across the road in front of vehicles. Slower speed of travel and increased public awareness can help reduce the number of fox/vehicle collisions that occur and reduce the impact of vehicle-related mortality on the fox population.

D. *Incorporate measures that increase roadside visibility into new or improved* roadways. Foxes are difficult to see if they are standing in roadside vegetation and sometimes run across the road in front of vehicles. Maintenance of short vegetation or gravel/pavement can increase visibility and help reduce the number of fox/vehicle collisions that occur and reduce the impact of vehicle-related mortality on the fox population.

III. Reduce the potential for an island fox population decline by removing or minimizing mortality factors and stressors.*

*A. Expand Island Fox Outreach and Education**

Some of the potentially adverse human impacts to the island fox population on San Clemente Island and San Nicolas Island could be reduced by raising the level of public awareness among Navy personnel stationed on the island. Although foxes are visible members of the island fauna, many residents are unaware of the species' vulnerabilities and needs.

1. Conduct a survey among on-island personnel to identify the current perceptions regarding natural resource management and the current level of public awareness about native species, including the island fox.
2. Use information gained during the survey effort to initiate an improved education program. Such an education program could educate personnel about the biology and conservation needs of the species, and train personnel how to spot foxes and avoid hitting them.
3. Continue to distribute island fox information pamphlets. Distribute a pamphlet to each visitor who leases a vehicle from the transportation department, to user commands during pre-training briefings, and assure pamphlet availability at the air terminal for all arriving visitors.
4. Continue to post informal "fox flyers" that educate personnel about island fox needs (i.e. potential detriment of feeding foxes, "watch out for foxes", etc.)

*B. Control the speed of roadway travel.**

The speed limit on SCI Ridge Road and paved surface roads was reduced on 5 February 2002 from 45 mph to 35 mph upon instruction from the Commanding Officer of Naval Base Coronado, and the Officer In Charge of San Clemente Island. Five speed limit signs were posted. The speed limit on dirt roads remains 15 mph.

1. On SCI, post and maintain additional speed limit signs in areas where fox collisions have occurred repeatedly and further south on Ridge Road in areas where drivers are consistently observed speeding.
2. Enforce the speed limit with appropriate actions.

The speed limit on San Nicolas Island is 35 mph on paved roads, 15 mph on dirt roads, and 15 mph in the living compound and airfield area.

1. On SNI, post and maintain additional speed limit signs where necessary.
2. Enforce the speed limit with appropriate actions.

C. Minimize, where possible, the number of vehicles traveling on island roads.

1. Encourage carpooling to worksites and training areas.
2. Determine the number of vehicles currently on SCI and SNI. Monitor the number of vehicles, determine and encourage a desired "carrying capacity" for vehicles on SCI and SNI.

D. Reduce potential adverse effects of pest management on the island fox.

Non-native rodents are absent from San Nicolas Island. Current efforts to prevent non-native rodents from colonizing this island are beneficial to the island fox and should be continued. Non-native mice and rodents are abundant and therefore controlled on San Clemente Island around facilities and in the field to protect listed avian species. Rodenticides can adversely affect island fox individuals if they ingest either the toxin itself or rodent(s) that have eaten the toxins. To avoid adverse effects to island foxes, the use of rodent traps, rather than rodenticides, should be maximized. Only rodenticides that have a minimal potential for secondary toxicity should be utilized on SCI and SNI. When rodenticide use is necessary, the poisons should be distributed only in bait boxes (rather than broadcast), and bait boxes should be modified to prevent fox access. To modify bait boxes to prevent fox access, the box should be securely staked to the ground (so a fox cannot drag the box), and size of the entry hole should be reduced to preclude a fox's head from fitting in the hole.

E. Conduct prophylactic vaccination of foxes where possible.

The potential for disease introduction, or spread of any disease that currently exists in the population at ambient levels remains a significant threat to the fox populations on SCI and SNI. Periodic assessment of blood samples will allow ongoing awareness of the levels of exposure to canine diseases in the fox populations on SCI and SNI. Vaccination of animals trapped during grid trapping or during intensified trapping efforts (transects) may become necessary and would increase immunity to some diseases in the event of an introduction/outbreak.

1. Vaccinate foxes against distemper (CDV) and other canine diseases in accordance with the recommendations of the Island Fox Recovery Team (convened for the listed Channel Islands subspecies). If blood samples reveal an increased level of CDV exposure throughout the population, initiate prophylactic vaccination of all animals handled during trapping.

*F. Do not allow dogs on SCI or SNI.**

Current Navy policies regarding pets on SCI and SNI islands prohibit dogs except those working as military dogs. These policies afford protection against disease introduction and should be maintained into the future. Contingency plans to address the potential for dogs swimming ashore from commercial and swimming vessels should also be established.

G. Consider establishing shoe cleaning stations at the airfields to reduce the potential for parvovirus transmission.
Some canine diseases can be transmitted not only be dogs, but by people or equipment that have been near dogs. Assuring that equipment and shoes are clean prior to use on the island would help reduce the potential for unintended disease transmission to SCI and SNI.

*H. Continue to manage the feral cat population on SCI. Reinitiate cat management efforts on San Nicolas Island.**
Feral cats may compete with island foxes for vertebrate prey items and may also represent an additional disease vector. Elimination of feral cat populations on SCI and SNI would be advisable, but is considered unfeasible. Ongoing management of the feral cat populations should be conducted to control the size of the feral cat population. This work is ongoing on SCI to benefit listed avian species, and can also benefit the island fox. Feral cat management efforts should be conducted in a fashion that minimizes the potential impacts to the island fox population. For example, large-scale trapping efforts should be conducted outside the fox breeding season to minimize the potential effects to the island fox. On SCI, the current recommendations of the predator management team are to focus on spot-lighting as the primary means of feral cat management.

I. Maintain refuse bin modifications on SNI and implement bin modifications on SCI.
Foxes will rummage through garbage containers and trash bins and may ingest harmful substances or become dependent upon these unnatural food sources. In addition, foxes can become trapped in such containers. On SNI, "exclusion bars" have been placed upon all trash bins. The bars prevent the trash bin lids from being left open by island personnel, thereby preventing foxes from entering.

IV. Restore native plant communities on SCI and SNI.

A. Reduce the prevalence of non-native annual grasslands. Remove annual grasslands by conducting controlled burns (outside the fox breeding season) or by using appropriate herbicide. Lower island fox densities are consistently detected in non-native grassland communities on SCI and SNI. Creating conditions that reduce the abundance of non-native grasslands and favor native grassland and shrubland communities should improve habitat quality for the island fox.

B. Continue weed control programs on SCI and SNI.

V. Employ an adaptive management strategy to assure that the conservation needs of the species are met in the event of a population decline.

A. Identify the magnitude of decline (or catastrophic event) that would warrant intervention or remedial action. The table below provides a general adaptive management outline for fox populations on SCI and SNI. This table and the adaptive

management approach should be refined during 2005 for inclusion in the next INRMP. This adaptive management approach is based on the premise that natural fluctuations occur in the island fox populations, but that as a decline begins, intensified monitoring and assessment will begin to better understand the nature of the decline and determine if remedial actions are necessary.

B. *Identify response mechanisms to be taken if population decline occurs.* Response mechanisms include intensified monitoring and, if necessary, additional measures such as supplemental feeding, vaccination, and, in a worse case scenario, taking animals into captivity.

Table 1. Adaptive management approach for San Clemente Island Fox.

Monitoring and Adaptive Management of Fluctuating Island Population during Periods of Non-Catastrophic Demographic Changes:				
POPULATION PARAMETER	**MONITORING METHOD**	**DATA TO BE COLLECTED**	**THRESHOLD FOR INTERVENTION**	**INTERVENTION PLAN**
Λ (population growth rate)	**Grid trapping** **Spotlighting**	Number of Animals, Age, Sex Ratio Population size through time	$\lambda < 0.94$	Further analysis of existing demographic info., Conduct radio-telemetry to refine demographic information Habitat enhancement
Fe (Fecundity)	**Grid trapping**	Body condition indices (Reproductive condition)	Age class structure askew	Radio-telemetry
Φ (Survivorship)	**Grid trapping** **Road Kill Database**	Age of individuals Recapture data	Survivorship decline of 30 percent	Vaccinations Radio-telemetry Transect surveys Supplemental feeding
Density estimates	**Grid trapping**	Number of animals Movement within and between grids	30 percent decline	Initiate transects and telemetry in plant community in which decline is observed
Population health	**Grid trapping** **Carcass collection and analysis**	Serosurveys, Necropsy, Body condition indices (tooth wear, nutritional condition, weight,)	Detection of new disease or increased prevalence of CDV…	Vaccinations Radio-telemetry Transect surveys Supplemental feeding
Adaptive Management/ Monitoring during Periods of Catastrophic Demographic Change or Potentially Catastrophic Events:				
Φ, Relative abundance	**Transects,** **Spotlighting**	Serosurveys Necropsy, Body condition indices	1 rabid animal, 15 animals CDV+, 30% decline in foxes/km	Vaccinate all trapped foxes Increase monitoring-Transects to get foxes in hand and observe condition of individuals
New predator, or increased number of predators	**Predator monitoring**	Predator types and abundance	Change in predator population compostion.	Conduct telemetry to determine impact of predators, conduct predator management

Population estimate	**Grid trapping, Transects, Spotlighting**	Serosurveys Necropsy, Body condition indices	Population estimate declines by 80% (using 2004 population estimate as baseline) OR number of individuals known alive drops below 50*****	Bring a number (to be determined) of foxes into captivity as hedge against extinction and as potential founders if captive breeding becomes necessary.

***** based on results of preliminary population viability analysis conducted for Channel Island Fox Recovery Team.

VI. Support research that provides additional information necessary for effective fox management.

A. Obtain additional information regarding den use and location.

B. Conduct noise study to determine if noise or vibration affects fox distribution and reproduction. If noise does affect foxes, minimize noise sources where possible.

C. Obtain additional information regarding fox biology, including survivorship, using radio telemetry.

D. Monitor variables that may be related to observed changes in fox population status, including: weather patterns, prey abundance, disease manifestation in the population, roadkill, etc. Where possible, measure these variables as population data is collected rather than conducting retrospective analyses.

1. Test all carcasses for emergent disease outbreaks. Maintain a database on results of all necropsies conducted on SCI foxes. Develop contingency plan that could be quickly implemented should a disease outbreak occur.

2. Test marine mammal populations for distemper to determine if this is an issue of concern for foxes.

3. Maintain data base of reported roadkills, including narrative (conditions surrounding collision, if known), vehicle speed at time of collision, mapped location, age of animal, and condition of road shoulder. Compilation of this information should assist in future management by documenting roadkill "hotspots".

4. Routinely monitor prey abundance.

5. Assess fox movement patterns on SCI and SNI. Do movement patterns affect the validity of population estimation techniques?

E. Continue participation on the Island Fox Recovery Team.
Participate in discussions and determinations regarding off-island breeding of island foxes.

Geographic Management Recommendations for San Clemente Island

Management Units, Fox Population Estimates, and Recommended Management Actions

UNIT (Fox population estimate) (% of total 681 foxes)	Management Actions to Benefit Island Fox
1, Northwest Harbor (12 foxes) (1.7%)	-Post and maintain10 additional signs along roadway to alert motorists to fox presence. -Post and maintain10 additional speed limit signs -Conduct additional education of personnel stationed at facilities in this management unit including distribution of pamphlets and fox video. -Increase speed limit enforcement in this management unit. -Maintain road shoulder to increase visibility adjacent to road.
2, Airfield (3 foxes) (0.4%)	-Post speed limit signs at all exits from airfield parking lot. -Distribute pamphlets in airport. -Periodically show fox video in airport waiting area. -Develop exhibit for airport showcase. Include example of caution signs, mount of fox, photographs, info, etc. -Maintain road shoulder to increase visibility adjacent to road.
3, Dolphin Bay (14 foxes) (2.0%)	No recommendations specific to this unit.
4, West Cove (35 foxes) (5.1%)	-Restore disturbances with MDS. -Minimize new disturbance to MDS.
5, Wilson Cove (2 foxes) (0.3%)	-Develop and conduct “natural resources of SCI” course that could be taken by island personnel for college credit. -Increase speed limit enforcement in this management unit -Post signs and distribute pamphlets in galley. Include poster that requests that personnel do not feed the foxes. -Inventory signs currently present in Wilson Cove. Add sufficient signs to assure that speed limit and caution signs are present at: (1) curve from airport approaching Wilson Cove, (2) before the grade into/out of Wilson Cove, (3) at the entrance/exit to the new BEQ buildings, (4) at the exit to the galley, and (5) at the entrance/exit to the older portion of Wilson cove. -Maintain road shoulder to increase visibility adjacent to road. -Conduct pest management using products and distribution techniques that are unlikely to adversely affect island foxes. Only rodenticide with little/no potential of secondary effects should be used. All rodenticide should be distributed in bait boxes that are modified to reduce the size of the entry hole and thereby prohibit fox entry. All bait boxes should be securely staked to the ground to prevent fox movement of/ damage to bait boxes. Recommend the use of Quintox as rodenticide of choice, but also recommend that trapping be emphasized as the primary means of rodent control to reduce the potential for toxicity to foxes.
6, NOTs Pier (8 foxes) (1.2%)	No recommendations specific to this unit.
7, Terrace Canyon (52 foxes) (7.6%)	Place 4 signs on road to West Shore to alert motorists to fox presence.
8, VC-3 (12 foxes) (1.8%)	No recommendations specific to this unit.
9, Lemon Tank (27 foxes) (4.0%)	-Remove annual grasses from this management unit to allow recovery of native shrublands and grasslands. A monitoring unit lies within the boundaries of this management unit, so habitat manipulation should allow assessment of effects to fox
10, Seal Cove	-Minimize disturbance to this area due to relative importance to the island fox.

(116 foxes) (17.0%)	-Restore disturbances with MDS. -Minimize new disturbance to MDS
11, Mt. Thirst (40 foxes) (5.9%)	-Distribute pamphlets at facilities at Mt. Thirst.
12, Lost Point (84 foxes) (12.3%)	-Minimize disturbance to this area due to relative importance to the island fox. -Restore disturbances with MDS. -Minimize new disturbance to MDS
13, Cave Canyon (59 foxes) (8.7%)	No recommendations specific to this unit.
14, Eagle Canyon (38 foxes) (5.6%)	No recommendations specific to this unit.
15, Upper China Canyon (24 foxes) (3.5%)	No recommendations specific to this unit.
16, China Cove (37 foxes) (5.4%)	No recommendations specific to this unit.
17, Pyramid Cove (95 foxes) (14.0%)	This management unit supports over 10 percent of the island fox population on SCI, however the area also has high military value, so no recommendations are specific to this unit.
18, Mosquito Cove (23 foxes) (3.4%)	No recommendations specific to this unit.

8. Measuring Effectiveness of Conservation Actions

The conservation actions described herein are expected to reduce threats to the island fox on SCI and on SNI. Specifically, effective implementation of the management guidelines should: reduce the number of collisions between island foxes and vehicles; reduce the potential for transmission of canine diseases; reduce competitive interactions with feral cats; reduce the potential for fox poisoning; increase the extent of native habitat favorable to island foxes; and minimize future disturbances to island foxes.

The effectiveness of the conservation actions can be indirectly measured by the status of the fox population on SCI and SNI. Refining monitoring and demographic studies will be important to the assessment of species status. Additionally, annual reports documenting the number of roadkills, the extent of annual grassland reduction (and effects to fox density estimates), and health of the population will allow determination of the effectiveness of the conservation actions described.

Implementation Schedule

Many of the conservation actions described in this document are dependent upon the annual availability of funds to support necessary conservation actions. The implementation schedule provided below is intended to provide a suggested schedule and basis for funding of management actions. These management guidelines are not a fund-obligating document.

Table 2. San Clemente Island: Conservation actions, expertise needed, projected cost ($) and projected year of implementation.

Conservation action	2005	2006	2007	2008	2009
Feral Cat Management	200,000	200,000	200,000	200,000	200,000
Habitat Restoration	Weed eradication 15,000	Annual grass removal 20,000	Annual grass removal 20,000	Annual grass removal 20,000	Annual grass removal 20,000
Sign installation and maintenance	Maintain/ Replace previously installed signs 5,000	Install new signs 20,000	Maintain/ Replace previously installed signs 7,000	----------	Maintain/ replace previously installed signs 7,000
Road shoulder clearing	40,000	30,000	20,000	15,000	15,000
Conduct Natural Resources Survey	---------	30,000	----------	----------	----------
Develop and offer natural resources course	----------	----------	20,000	20,000	20,000
Distribute Pamphlets	Ongoing 0 (zero cost)	Ongoing 0	Print additional pamphlets, 1000	Ongoing 0	Ongoing 0
Conduct monitoring study		125,000	150,000	150,000	150,000
Assess current population estimation techniques	30,000	----------	----------	----------	----------
Necropsy all foxes and maintain database	3000	3000	3000	3000	3000
Avoid pupping season, where feasible	0 (zero cost)	0	0	0	0
Vaccinate 50 foxes	500	500	500	500	500
Prohibit dogs	0 (zero cost)	0	0	0	0
Conduct Research	--------	30,000	30,000	30,000	30,000
Employ adaptive management strategy	tbd	tbd	tbd	tbd	tbd
Continue Recovery Team Participation	250	250	250	250	250
TOTAL	**293,750**	**458,750**	**451,750**	**438,750**	**445,750**

Table 3. San Nicolas Island: Conservation actions, expertise needed, projected cost and projected year of implementation.

Conservation action	2005	2006	2007	2008	2009
Feral Cat Management	40,000	40,000	40,000	40,000	40,000
Habitat Restoration	Weed eradication 20,000	Weed eradication 25,000	Weed eradication 25,000	Annual grass removal 20,000	Annual grass removal 20,000
Sign installation and	0	2,000	0	0	2,000

maintenance					
Road shoulder clearing	15,000	15,000	15,000	15,000	20,000
Distribute Pamphlets	Ongoing 0 (zero cost)	Ongoing 0	Print additional pamphlets, 1000	Ongoing 0	Ongoing 0
Conduct grid-based monitoring study	30,000	30,000	35,000	35,000	45,000
Assess current population estimation techniques	0 (zero cost)	----------	----------	----------	----------
Necropsy all foxes and maintain database	3,000	3,000	3,000	3,000	3,000
Avoid pupping season, where feasible	0 (no cost)	0 (no cost)	0 (no cost)	0 (no cost)	0 (no cost)
Vaccinate 50 foxes	500	500	500	500	500
Prohibit dogs	0 (no cost)	0	0	0	0
Continue Recovery Team Participation	0 (no cost)	0	0	0	0
TOTAL	**108,500**	**115,500**	**119,500**	**113,500**	**130,500**

9. Literature Cited

Allee, W. C. 1931. Animal Aggregations. A study in General Sociology. University of Chicago Press, Chicago.

Baird, S.F. 1857. General report upon the zoology of the several Pacific Railroad Routes. I. Mammals. In: Reports of explorations and surveys to ascertain the most practicable and economical route for a railroad from the Mississippi River to the Pacific Ocean, Vol. 8. Washington, D.C.

Bauman, J.E., C.S. Asa, and T.J. Coonan. 2001. Evidence for Induced Ovulation in Channel Islands Gray Foxes (Urocyon littoralis). Abstract accepted for presentation at the International Canid Biology and Conservation Conference, Oxford University, September 17-21, 2001.

Brenton, B. and R. Klinger. 1994. Modeling the expansion of fennel *(Foeniculum vulgare)* on the Channel Islands. Pages 497-504 *in* Halvorson, W., and G. Meander, (eds.), The Fourth Channel Islands Symposium: Update on the Status of Resources. Santa Barbara Museum of Natural History: Santa Barbara, CA.

Brumbaugh, R. W. 1980. Recent geomorphic and vegetal dynamics on Santa Cruz Island, California. In: D.M. Power (ed.). Natural Resources Study of the Channel Islands National Monument, California. Prepared for the National Park Service, Denver Service Center by the Santa Barbara Museum of Natural History, Santa Barbara, California.

California Department of Fish and Game. 1987. Five-year status report on the island fox. Unpublished report, California Department of Fish and Game, Sacramento, California.

Carlquist, S. 1974. Island biology. Columbia University Press, New York.

Clark, R. A., W. L. Halvorson, A.A. Sawdo, and K. C. Danielsen. 1990. Plant communities of Santa Rosa Island, Channel Islands National Park. Tech. Report No. 42. Cooperative National Park Resources Studies Unit, University of California, Davis.

Coblentz, B. E. 1980. Effects of feral goats on the Santa Catalina Island ecosystem. In: D.M. Power (ed.). Natural Resources Study of the Channel Islands National Monument, California. Prepared for the National Park Service, Denver Service Center by the Santa Barbara Museum of Natural History, Santa Barbara, California.

Collins, P.W. 1980. Food ha Collins, P.W. 1980. Food habits of the island fox (Urocyon littoralis littoralis) on San Miguel Island, California. In: Proceedings of the 2nd Conference on Scientific Research in the National Parks. Volume 12: Terrestrial Biology and Zoology. National Park Service, Washington D.C. NTIS.P881-100133.

Collins, P.W. and L.L. Laughrin. 1979. Vertebrate zoology: the island fox on San Miguel Island. In: D.M. Power (ed.). Natural Resources Study of the Channel Islands National Monument, California. Prepared for the National Park Service, Denver Service Center by the Santa Barbara Museum of Natural History, Santa Barbara, California.

Collins, P.W. 1991a. Interaction between island foxes (Urocyon littoralis) and Indians on islands off the coast of southern California: I. morphologic and archaeological evidence of human assisted dispersal. Journal of Ethnobiology, 11(1):51-81.

Collins, P.W. 1991b. Interaction between island foxes (Urocyon littoralis) and Native Americans on islands off the coast of southern California: II. Ethnographic, archaeological, and historical evidence of human assisted dispersal. Journal of Ethnobiology, 11(2):205-229.

Collins, P.W. 1993. Taxonomic and biogeographic relationships of the island fox (Urocyon littoralis) and gray fox (U. cinereoargenteus) from Western North America. In: F.G. Hochberg, (ed). Third California Islands Symposium: Recent Advances in Research on the California Islands. Santa Barbara Museum of Natural History: Santa Barbara, California. 661 pp.

Cooper, D. M., E. L. Kershner, G. A. Schmidt, D. K. Garcelon. 2001. San Clemente loggerhead shrike predator research and management program-2000. Final Report. U.S. Navy, Natural Resources Management Branch, Southwest Division Naval Facilities Engineering Command, San Diego, California.

Cooper, D.M. and D.K. Garcelon. 2003. San Clemente island fox management and research to protect the San Clemente loggerhead shrike on NALF San Clemente Island, California, during 1999. Unpublished report prepared by the Institute for Wildlife Studies, Arcata California for the U.S. Navy, Soutwest Division Naval Facilities Engineering Command, San Diego, California.

Cooper, D.M., E.L. Kershner, B.L. Sullivan, and D.K. Garcelon. 2003. San Clemente loggerhead shrike predator research and management program-2001. Final Report. U.S. Navy, Natural Resources Management Branch, Southwest Division Naval Facilities Engineering Command, San Diego, California.

Coonan, T.J. 2001. Findings of the island fox conservation working group, June 20-21, 2001, Ventura, California.

Coonan, T.J. 2003a. Recovery strategy for island foxes (Urocyon littoralis) on the northern Channel Islands. National Park Service, Channel Islands National Park. August 2003.

Coonan, T.J. 2003b. Findings of the island fox conservation working group, June 24-26, 2003, Ventura, California

Coonan, T.J., G. Austin, and C.A. Schwemm. 1998. Status and trend of island fox, San Miguel Island, Channel Islands National park. Technical Report 98-01. National Park Service.

Coonan, T.J., C.A. Schwemm, G. W. Roemer, and G. Austin. 2000. Population decline of island foxes (Urocyon littoralis littoralis) on San Miguel Island. D.R. Browne, K.L. Mitchell, and H.W. Chaney, Eds. Proceedings of the 5^{h} Channel Islands Symposium. U.S. Department of the Interior, Mineral Management Service.

Coonan, T. J. and K. Rutz. 2002. Island fox captive breeding program, 2001 annual report. Technical Report 02-01. National Park Service, Channel Islands National Park.

Coonan, T.J. and K. Rutz. 2003. Island fox captive breeding program 2002 annual report. Technical Report 03-01. National Park Service, Channel Island National Report.

Coonan, T.J., C.A. Schwemm, G.W. Roemer, and D.K. Garcelon. In review. Decline of island foxes to near extirpation on San Miguel Island, California. Southwestern naturalist.

Coonan, T. J., K. Rutz, D. K. Garcelon, B. C. Latta, M. M. Gray, and E. T. Aschehoug. In prep. Progress in island fox recovery efforts on the northern Channel Islands. Manuscript prepared for publication in the proceedings of the Sixth California Islands Symposium, December 1-4, 2003, Ventura, California.

Courchamp, F., M. Langlais, and G. Sugihara. 1999. Control of rabbits to protect island birds from cat predation. Biological Conservation 89:219-225.

Crooks, K.R. and D. Van Vuren. 1995. Resource utilization by two insular endemic mammalian carnivores, the island fox and the island spotted skunk. Oecologia, 104: 301-307.

Crooks, K.R. and D. Van Vuren. 1996. Spatial organization of the island fox (Urocyon littoralis) on Santa Cruz Island, California. Journal of Mammalogy, 77(3):801-806.

Crowell, H.E.D. 2001. Food habits and prey availability of the threatened San Miguel island fox (Urocyon littoralis littoralis) during a decline in population, 1993-1998. Master's thesis, California Polytechnic State University.

Dennis, M., K. Randall, G. Schmidt, and D. Garcelon. 2001. Island fox (Urocyon littoralis santacruzae) distribution, abundance, and survival on Santa Cruz Island, California. Institute for Wildlife Studies. Progress report for May through October 2001. October 2001.

Department of the Navy. 1963. Memorandum of agreement between the Department of the Navy and the Department of the Interior relating protection of natural values and historic and scientific objects on San Miguel and Prince Islands, California.

Department of the Navy. 1976. Amendment to memorandum of agreement between the Department of the Interior and the Department of the Navy relating to protection of natural values and historic and scientific objects on San Miguel and Prince Islands, California.

Department of the Navy. 1985. Interagency agreement supplementing memorandum of agreement (dated 7 May 1963) and amended (20 October 1976) between the Departments of Interior and Navy regarding San Miguel Island.

Department of the Navy. 2002. San Nicolas Island, Integrated Natural Resources Management Plan, 2003-2007. Environmental Planning and Management Department.

Diamond, J.M. and H.L. Jones. 1980. Breeding land birds of the Channel Islands. In: D.M. Power ed. The California Islands: proceedings of a multidisciplinary symposium. Santa Barbara Museum of Natural History, Santa Barbara. Pp.597-612.

Fausett, L.L. 1993. Activity and movement of the island fox, Urocyon littoralis, on Santa Cruz Island, California. In: F.G. Hochberg, ed. Third California Islands Symposium: Recent Advances in Research on the California Islands. Santa Barbara Museum of Natural History: Santa Barbara, California.

Fritcher, D., J.A.K. Mazet, and L. Munson. In prep. Island Fox Serosurvey Progress Report.

Garcelon, D.K. 1988. Demographics of the island fox in selected areas at San Clemente Island. Prepared under contract no. N62472-87-M4098 for the Natural Resources Office of the North Island Naval Air Station, San Diego, California.

Garcelon, D.K. 1999. Island fox population analysis and management recommendations. Unpublished report submitted to: Southwest Division, Naval Facilities Engineering Command, San Diego, California.

Garcelon, D.K., G.W. Roemer, and G.C. Brundige. 1991. The biology of the island fox on San Clemente and Santa Catalina islands, California. A final report submitted to the Nongame Bird and Mammal Section, Wildlife Management Branch, California Department of Fish and Game, Contract No. FG-9402.

Garcelon, D.K., R.K. Wayne, and B.J. Gonzales. 1992. A serologic survey of the island fox (Urocyon littoralis) on the Channel Islands, California. Journal of Wildlife Management, 28(2):223-229.

Garcelon, D. K., G. W. Roemer, R.B. Philips, and T.J. Coonan. 1999. Food provisioning by island foxes, *Urocyon littoralis*, to conspecifics caught in traps. The Southwestern Naturalist 44(1): 83-86.

Gilbert, D.A., N. Lehman, S.J. O'Brien, and R.K. Wayne. 1990. Genetic fingerprinting reflects population differentiation in the California Channel Island fox. Nature, 344:764-767.

Gill, A.E. 1980. Evolutionary genetics of California islands Peromyscus. In: D.M. Power ed. The California Islands: proceedings of a multidisciplinary symposium. Santa Barbara Museum of Natural History, Santa Barbara. Pp.597-612.

Goldstein, D.B., G.W. Roemer, D.A. Smith, D.E. Reich, A. Bergman, and R.K.Wayne. 1999. The use of microsatellite variation to infer population structure and demographic history in a natural model system. Genetics 151:797-801.

Gray, M.M., G.W. Roemer, and E. Torres. 2001. The genetic assessment of relatedness among individuals in the Channel Island Fox Captive Breeding Program. Draft Document.

Grinnell, J., J.S. Dixon, and J.M. Linsdale. 1937. Fur-bearing mammals of California: their natural history, systematic status, and relations to man. University of California Press, Berkeley, California, 2:452-471.

Guthrie, D.A. 1993. New information on the prehistoric fauna of San Miguel Island, California. In: F.G. Hochberg, (ed). Third California Islands Symposium: Recent Advances in Research on the California Islands. Santa Barbara Museum of Natural History: Santa Barbara, California. Pp.405-416.

Hall, E. R. and K. R. Kelson. 1959. Mammals of North America, Volume II. Ronald Press Company, New York.

Hochberg, M., S. Junak, R. Philbrick, and S. Timbrook. 1979. Botany. In Power, D. M. (ed.), Natural Resources Study of the Channel Islands National Monument, California. Report submitted to the National Park Service. Santa Barbara Museum of Natural History, Santa Barbara, California.

Johnson, D.L. 1978. The origin of island mammoths and the Quaternary land bridge history of the northern Channel Islands, California. Quaternary Research10:204-225.

Johnson, D. L. 1980. Episodic vegetation stripping, soil erosion, and landscape modification in prehistoric and recent historic time, San Miguel Island, California. In: D.M. Power (ed.). Natural Resources Study of the Channel Islands National Monument, California. Prepared for the National Park Service, Denver Service Center by the Santa Barbara Museum of Natural History, Santa Barbara, California.

Johnson, D. L. 1983. The California continental borderland: landbridges, watergaps and biotic dispersals. Quaternary Coastlines, 1983: 481-527.

Jones, J.A., S.A. Junak, and R.J. Paul. 1993. Progress in mapping vegetation on Santa Cruz Island and a preliminary analysis of relationships with environmental factors. In: F.G. Hochberg, (ed). Third California Islands Symposium: Recent Advances in Research on the California Islands. Santa Barbara Museum of Natural History: Santa Barbara, California. Pp. 97-104.

Jones, H. L. and P. W. Collins. In prep. Birds of California's Channel Islands.

Kiff, L.F. 1980. Historical changes in resident populations of California islands raptors. In: D.M. Power ed. The California Islands: proceedings of a multidisciplinary symposium. Santa Barbara Museum of Natural History, Santa Barbara. Pp.651-673.

Klinger, R. C., P. T. Schuyler, and J. D. Sterner. 1994. Vegetation response to the removal of feral sheep from Santa Cruz Island. In: W.L Halverson and G.J. Maender, eds. The Fourth California Channel Islands Symposium: Update on the Status of Resources. Santa Barbara Museum of Natural History, Santa Barbara, CA.

Kohlmann, S.G., G.A. Schmidt, R.C. Wolstenhome, and D.K. Garcelon. 2003. Island fox recovery efforts on Santa Catalina Island, California, October 2001-2002, Annual report. Unpublished report by the Institute for Wildlife Studies, Arcata, California for the Ecological Restoration Department, Santa Catalina Island Conservancy, Avalon, California.

Kovach, S.D. and R.J. Dow. 1981. Status and ecology of the island fox on San Nicolas Island, 1980. Pacific Missile Test Center, Point Mugu, California 93042.

Kovach, S.D. and R.J. Dow. 1982. Ecology of island fox and feral cats on San Nicholas Island. In: Dow, R.J. ed. Biennial Mugu Lagoon/San Nicholas Island Ecological Research Symposium. Pacific Missile Test Center, October 28-29, 1982. Pp.439-453.

Kovach, S.D. and R.J. Dow. 1985. Island fox research, San Nicholas Island, Ventura County, California: 1984 Annual Report. Unpublished report to the California Department of Fish and Game. 19 pp.

Laughrin, L.L. 1971. Preliminary account of the island fox. Supported in part by Federal Aid in Wildlife Restoration, project W-54-R, Special Wildlife Investigations.

Laughrin, L.L. 1973. California island fox survey. State of California Department of Fish and Game, Wildlife Management Branch Administrative Report 73-3.

Laughrin, L.L. 1977. The island fox: a field study of its behavior and ecology. Ph.D. dissertation, University of California, Santa Barbara. 83 pp.

Laughrin, L.L. 1978. Status report on the San Nicholas Island Fox. University of California, Santa Barbara.

Laughrin, L.L. 1980. Population and status of the island fox. In: D.M. Power ed. The California Islands: proceedings of a multidisciplinary symposium. Santa Barbara Museum of Natural History, Santa Barbara. Pp.745-750.

Latta, B. 2001. Channel Islands Golden Eagle Research and Translocation Project. 1999-2002 Progress Report. Santa Cruz Predatory Bird Research Group.

Latta, B. 2003. Draft Channel Islands Golden Eagle Research and Translocation Project. 2003 Progress Report. Santa Cruz Predatory Bird Research Group.

Lockie, J.D. 1964. The breeding density of the golden eagle and fox in relation to food supply in Wester Ross, Scotland. Scottish naturalist, 71: 67-77.

MacArthur, R.H. and E.O. Wilson. 1967. The theory of island biogeography. Princeton University Press. 203 pp.

Merriam, C.H. 1888. Description of a new fox from southern California. Proceedings of the Biological Society of Washington, 4:135-138.

Merriam, C.H. 1903. Eight new mammals from the United States. Proceedings of the Biological Society of Washington, 16:73-78.

Moore, C.M. and P.W. Collins, 1995. Urocyon littoralis. Mammalian Species, No. 489:1-7.

National Park Service. 1991. Natural Resources Management Guidelines. NPS-77. Washington, D.C.

National Park Service. 1985. General management plan for Channel Islands National Park, Vol. 1. Ventura, California.

National Park Service. 2002. Santa Cruz Island Primary Restoration Plan. Final Environmental Impact Statement. U.S. Department of Interior, Channel Islands National Park, Ventura California.

O'Brien, S.J. and J.F. Evermann. 1988. Interactive influence of infectious disease and genetic diversity in natural populations. Trends in Ecology and Evolution, 3:254-59.

O'Malley, P. G. 1994. Animal husbandry on the three southernmost Channel Islands: a preliminary overview, 1820-1950. In: W.L Halverson and G.J. Maender, eds. The Fourth California Channel Islands Symposium: Update on the Status of Resources. Santa Barbara Museum of Natural History, Santa Barbara, CA.

Orr, P.C. 1968. Prehistory of Santa Rosa Island, Santa Barbara Museum of Natural History, Santa Barbara, California, 253 pp.

Peart, D., D. T. Patten, and S. L. Lohr. 1994. Feral pig disturbance and woody species seedling regeneration and abundance beneath coast live oaks (*Quercus agrifolia*) on Santa Cruz Island, California. In: W.L Halverson and G.J. Maender, eds. The Fourth California Channel Islands

Symposium: Update on the Status of Resources. Santa Barbara Museum of Natural History, Santa Barbara, CA.

Phillips, R. B. and R. H. Schmidt. 1997. Feral Cat Management Plan for Naval Auxiliary Landing Field, San Clemente Island, California. Submitted to the Natural Resources Office, NAS North Island, U.S. Navy by the Department of Fisheries and Wildlife, Utah State University, Logan Utah.

Propst, B. 1975. A population survey of the Santa Catalina Island fox. A report to the California Department of Fish and Game, Nongame Wildlife Investigation Project W-54-R-8, Job I-1.10. 8 pp.

Roelke-Parker, M.E., L. Munson, and C. Packer. 1996. A canine distemper virus epidemic in Serengeti lions. Nature, 379:441-445.

Roemer, G.W. 1999. The ecology and conservation of the island fox. Ph.D. dissertation, University of California, Los Angeles.

Roemer, G.W. 2000. Annual progress report 2000: summary of the demography of the San Nicolas island fox (Urocyon littoralis dickeyi).

Roemer, G.W., D.K. Garcelon, T.J. Coonan, and C. Schwemm. 1994. The use of capture-recapture methods for estimating, monitoring, and conserving island fox populations. In: W.L Halverson and G.J. Maender, eds. The Fourth California Channel Islands Symposium: Update on the Status of Resources. Santa Barbara Museum of Natural History, Santa Barbara, CA.

Roemer, G.W., T.J. Coonan, D.K.Garcelon, C.H. Starbird, and J.W. McCall. 2000. Spatial and temporal variation in the seroprevalence of canine heartworm antigen in the island fox. Journal of Wildlife Diseases 36: 723-728.

Roemer, G.W., D.A. Smith, D.K.Garcelon, and R.K.Wayne. 2001a. The behavioural ecology of the island fox (Urocyon littoralis). Journal of Zoology, 255: 1-15.

Roemer, G.W., T.J. Coonan, D. K. Garcelon, J. Bascompte, and L.Laughrin. 2001b. Feral pigs facilitate hyperpredation by golden eagles and indirectly cause the decline of the island fox. Animal Conservation, 4:1-12.

Roemer, G.W., T.J. Coonan, L. Munson, and R.K.Wayne. 2001c. Canid Action Plan: Island Fox (Urocyon littoralis).

Roemer, G. W., C.J. Donlan, and F. Courchamp. 2002. Golden eagles, feral pigs, and insular carnivores: how exotic species turn native predators into prey. Proceedings of the National Academy of Sciences, USA 99: 791-796.

Roemer, G.W. and R.K. Wayne. 2003. Conservation in Conflict: the tale of two endangered species. Conservation Biology, 17(5): 1251-1260.

Roemer, G. W., P. S. Miller, T. J. Coonan J. Laake, and C. Wilcox. In prep. Population viability analysis and a conservation strategy for the critically endangered island fox.

Schmidt, G.A. and D.K. Garcelon. 2003. Island fox monitoring and demography on San Nicolas Island—2002. Unpublished report prepared by the Institute for Wildlife Studies, Arcata, California.

Schreiner, E., J. Menke, and D.L. Peterson. 2003. Progress report on the monitoring and status of two indicator plant species, Arctostaphylos confertiflora and Castilleja molis, and their habitats on Santa Rosa Island, Channel Islands National Park: 2002. Unpublished report prepared for the Vail Family Members, the Vickers Company Ltd. and the National Park Service.

Templeton, A.R. 1994. Biodiversity at the molecular genetic level: experiences from disparate macroorganisms. Philosophical Transactions of the Royal Society of London Biological Sciences, 345(1311):59-64.

Thompson, C.M., E.L. Stackhouse, G.W. Roemer, and D.K.Garcelon. 1998. Home range and density of the island fox in China Canyon, San Clemente Island, California. U.S. Navy, Natural Resources Mangement Branch, Southwest Division, Naval Facilities Engineering Command, San Diego, California.

Timm, S.F., J.M. Stokely, T.B. Gehr, R.L. Peebles, and D.K. Garcelon. 2000. Investigation into the decline of island foxes on Santa Catalina Island. Prepared for the Ecological Restoration Department, Santa Catalina Island Conservancy.

Valoppi, L, D. Welsh, D. Glaser, P. Sharpe, D. Garcelon, and H. Carter. 2000. Final Predictive Ecological Risk Assessment for the Potential Reintroduction of Bald Eagles to the Northern Channel Islands. U.S. Fish and Wildlife Service, Region 1, Sacramento Fish and Wildlife Office. Prepared for the Southern California Damage Assessment Trustee Council.

Vellanoweth, R. L. 1998. Earliest island fox remains on the southern Channel Islands: evidence from San Nicolas Island, California. Journal of California an Great Basin Anthropology, 20(1): 100-108.

Von Bloeker, Jr. 1967. Land mammals of the southern California islands. In: R.N. Philbrick, ed. Proceedings of the symposium on the biology of the California islands. Santa Barbara Botanic Garden, Santa Barbara, California.

Watson, A., S. Payne, and S.R.. Rae. 1989. Golden eagles, Aquila chrysaetos, land use and food in northeast Scotland. Ibis, 131: 336-348.

Watson, J., S.R. Rae, and R. Stillman. 1992. Nesting density and breeding success of golden eagles, Aquila chrysaetos, in relation to food supply in Scotland. Journal of Animal Ecology, 61: 543-550.

Wayne, R.K., S.B. George, D. Gilbert, P.W. Collins, S.D. Kovach, D. Girman, and N. Lehman. 1991. A morphologic and genetic study of the island fox, Urocyon littoralis. Evolution 45(8):1849-1868.

Wilson, R.L. 1976. The status of the island fox, San Clemente Island. Progress Report 1. Natural Resources Program, Naval Undersea Center, San Diego, California.

Wolstenholme, R.C., G.A. Schmidt, D.K. Garcelon, C.C. Newman, and A.G. Dillon. 2003. Island fox monitoring and research on Naval Auxiliary Landing Field, San Clemente Island, California. Unpublished report prepared by the Institute for Wildlife Studies, Arcata, California.

Florida Bog Frog

Management Guidelines for Species at Risk on Department of Defense Installations

NatureServe

Florida Natural Areas Inventory

NatureServe is a non-profit organization that provides the scientific basis for effective conservation.

Citation:
Jackson, D.. 2004. *Florida Bog Frog: Management Guidelines for Species at Risk on Department of Defense Installations.* NatureServe, Arlington, Virginia.

This work was made possible with funding from the U.S. Department of Defense and the U.S. Fish and Wildlife Service.

Front cover photo: Florida bog frog (*Rana okaloosae*) by David Printiss.

NatureServe
1101 Wilson Boulevard, 15th Floor
Arlington, VA 22209
703-908-1800
www.natureserve.org

Florida Natural Areas Inventory
1018 Thomasville Road, Suite 200-C
Tallahassee, FL 32303
850-224-8207
www.fnai.org

FLORIDA BOG FROG

MANAGEMENT GUIDELINES FOR SPECIES AT RISK ON DEPARTMENT OF DEFENSE INSTALLATIONS

EGLIN AIR FORCE BASE
FLORIDA

Dale R. Jackson

September 2004

Acknowledgements

The previous work and cooperation of three biologists made completion of this document possible. David Bishop, Paul Moler, and David Printiss all assisted with field reconnaissance of Florida bog frog localities and shared their knowledge of the biology and conservation needs of the species. Bruce Hagedorn provided information about Eglin Air Force Base and its management programs that address the frog.

The U.S. Department of Defense Legacy Program provided funding for the project; Patricia Kelly (U.S. Fish and Wildlife Service) and Nancy Benton (NatureServe) were especially instrumental in securing and directing these funds.

This document benefited from the review comments of numerous biologists from many organizations and agencies; these included J.J. Bachant Brown, David Bishop, Dick Franz, Daniel Friese, Richard Gooch, Bruce Hagedorn, John Jensen, Patty Kelly, Bob Miller, Paul Moler, David Printiss, and Dennis Teague. David Printiss kindly granted permission to use his photographs of the bog frog (cover and Fig. 2). David Whitehouse facilitated access to International Paper lands, Edwin Abbey offered technical assistance, and J.J. Bachant Brown provided useful literature.

Table of Contents

ACKNOWLEDGEMENTS iv
EXECUTIVE SUMMARY 1
1. SPECIES IDENTIFIERS 2
2. SPECIES STATUS 2
3. RELATIONSHIP TO DOD 2
a. Installation Where Species Occurs 2
b. Existence of INRMP and Focus on Florida Bog Frog 4
4. CONTACTS 4
a. Primary Contact 4
b. Management Guidance Document Author 4
c. DOD Contact 4
d. USFWS Contacts 5
e. Natural Heritage Program Contact 5
f. NatureServe Contact 5
g. Expert Contacts 5
h. Additional Stakeholder Contacts and Interests 8
5. SPECIES INFORMATION 11
a. Species Description 11
b. Distribution 13
c. Habitat 15
d. Life History 16
e. Populations 17
f. Survey Methodology 18
6. SPECIES CONSERVATION 19
a. Conservation Strategy and Objectives 19
b. Threats and Management Solutions 22
1. Fire Suppression and Habitat Succession 23
2. Erosion, Siltation, and Flooding (Roads and Borrow Pits 24
3. Impoundment 26
4. Invasive Non-Native Species 27
5. Pollution 29
6. Impacts of Military Training and Testing 30
7. Silvicultural Operations 31
8. Habitat Fragmentation 31
9. Hybridization 32
10. Other Potential Threats 32

c. Conservation Actions: Adaptive Management and Monitoring 35
d. Measuring Effectiveness of Conservation Actions 38
e. Impacts to Other Imperiled Species 39
7. SPECIES RESEARCH.....40
a. Current Research Programs 40
b. Further Research Needs 40
8. INFORMATION MANAGEMENT 42
9. FEASIBILITY 43
a. Legal Authority 43
b. Time frame 43
c. Costs 43
d. Potential Funding Sources for Management Implementation 44
REFERENCES 46
Appendix 1. Eglin AFB Integrated Natural Resource Management Plan section addressing the Florida bog frog 49
Appendix 2. Florida bog frog site data 50
Appendix 3. Eglin AFB Integrated Natural Resource Management Plan section addressing erosion control and road management 53
Appendix 4. Copy of Yellow River Ravines project account and map from Florida Forever Five Year Plan 2003 55
Appendix 5. Map and parcel information depicting lands for consideration for addition to the Florida Forever Yellow River Ravines project.....58
Appendix 6. Reviewers and affiliations.....60

LIST OF TABLES

Table 1. Conservation Management Units and Conservation Priorities for the Florida bog frog 21
Table 2. Summary of recommended conservation priorities by drainage and Conservation Management Unit 22
Table 3. Partial list of known bog frog sites in need of management attention, listed by FNAI occurrence number within CMU priority categories 34

LIST OF FIGURES

Fig. 1 Eglin Air Force Base regional setting and location 3
Fig. 2. Photographs of the Florida bog frog 12
Fig. 3. Map of known localities of the Florida bog frog 14

Executive Summary

The Florida bog frog, *Rana okaloosae*, is a small ranid frog endemic to three counties in western Florida. It is most closely related to the bronze (or green) frog, *Rana clamitans*, and is the smallest member of its genus in North America. The bog frog is restricted to a variety of seepage habitats, relatively stable streams and seeps that receive their water via percolation through adjacent, deep sandy uplands. The species was not discovered until 1982 and was formally described in 1985 (Moler 1985a). The few studies to date that have been conducted on it have been predominantly distributional surveys, although investigation of its ecology is underway (Bishop, 2004).

Despite surveys that have extended to several river drainages, the species remains known from only two, the Yellow and East Bay rivers, both of which empty into the Pensacola Bay system. Of approximately 57 known sites, all but five are located in roughly the western third of Eglin Air Force Base (AFB), Santa Rosa and Okaloosa counties, Florida. Two highly disjunct sites occur in the northeastern part of Eglin AFB, in Walton County, in Titi Creek, a tributary of the Yellow River via the Shoal River. The remaining three sites are on private lands on the north side of the Yellow River, across from Eglin AFB. In this document, sites are consolidated into Conservation Management Units (essentially individual tributary stream drainages or river floodplains) that are assigned to one of three drainages – Titi Creek, Yellow River, or East Bay River.

Conservation objectives for the Florida bog frog fall into two principal categories: 1) managing riparian and adjacent upland habitat on Eglin AFB to be optimal for the species, and 2) securing legal protection of private lands known to support the species so that they, too, can be managed appropriately. The state of Florida, through it Florida Forever program, has initiated steps to achieve the second goal, although there is no guarantee of success at this point.

Threats to the Florida bog frog stem primarily from factors that degrade or destroy its rather open, seepage microhabitats. Known and potential threats include fire suppression and habitat succession; erosion, siltation, and flooding (roads and borrow pits); impoundment; invasive non-native species (principally hogs and plants); pollution; impacts of military training and testing; silvicultural operations; habitat fragmentation; and potentially hybridization. This document elaborates upon each of these and discusses potential conservation measures to mitigate them.

1. SPECIES IDENTIFIERS

Scientific Name:	*Rana okaloosae*
Common Name:	Florida bog frog
Family:	Ranidae
Order:	Anura
Class:	Amphibia

2. SPECIES STATUS

Federal Status (Candidate):	No
State Status:	Species of Special Concern
Heritage Status Rank:	Global Rank: G2
	State Rank: S2

In addition, the Florida Committee on Rare and Endangered Plants and Animals lists the species as Rare (Moler, 1992).

3. RELATIONSHIP TO DOD

a. Installation Where Species Occurs

More than 90% of known Florida bog frog localities occur on Eglin Air Force Base (AFB), Florida (Fig. 1).

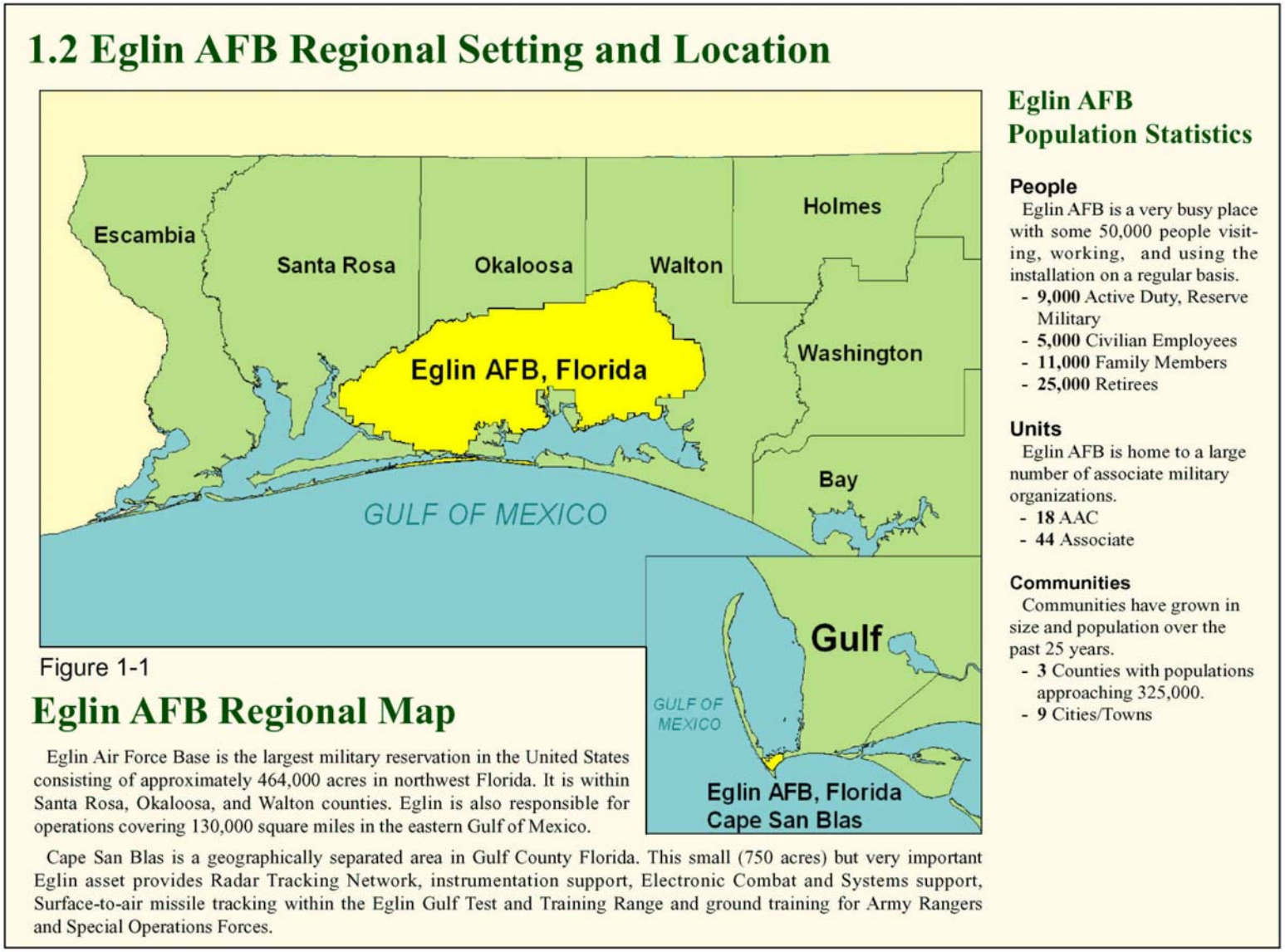


Figure 1. Eglin Air Force Base regional setting and location (from Eglin AFB Integrated Natural Resources Management Plan).

b. Existence of INRMP and Focus on Florida Bog Frog

Eglin AFB has an Integrated Natural Resources Management Plan (INRMP), last revised February 2002 (U.S. Air Force, 2002). Achievement of the plan's goals is under the direction of the base's Natural Resources Branch (NRB). General goals of the INRMP that are most pertinent to the Florida bog frog (or hereafter, simply the bog frog) are: conservation and rehabilitation of natural resources; fish and wildlife management and habitat enhancement; and wetland protection, enhancement, and restoration where necessary for support of wildlife.

The Eglin AFB INRMP includes the Bog frog as one of eight species considered to be Conservation Targets on the base. Desired future conditions for these targets were drawn from a report prepared by The Nature Conservancy (Sutter et al., 2001). The specific section of the INRMP outlining management direction for the species is attached as Appendix 1. Emphasis is placed on distributional surveys and studies of population ecology.

4. CONTACTS

a. Primary Contact

Patricia Kelly, U.S. Fish and Wildlife Service (USFWS; see 4.d)

b. Management Guidance Document Author

Dr. Dale R. Jackson, Florida Natural Areas Inventory (FNAI; see 4.e)

c. DOD Contact

Bruce Hagedorn, Supervisory Wildlife Biologist
Eglin AFB, Natural Resources Branch
107 Hwy 85 North
Niceville, FL 32578
phone: (850) 882-4164 x 325
fax: (850) 882-5321
e-mail: hagedorn@eglin.af.mil

d. USFWS Contacts

Patricia Kelly, Biologist
U.S. Fish and Wildlife Service
Panama City Ecological Services Field Office
1601 Balboa Avenue
Panama City, FL 32405
phone: (850) 769-0552 x 228
fax: (850) 763-2177
e-mail: Patricia_Kelly@fws.gov

Janet Mizzi, Assistant Field Supervisor
U.S. Fish and Wildlife Service
Panama City Ecological Services Field Office
1601 Balboa Avenue
Panama City, FL 32405
phone: (850) 769-0552
fax: (850) 763-2177
e-mail: Janet_Mizzi@fws.gov

e. Natural Heritage Program Contact

Dr. Dale R. Jackson, Research Zoologist
Florida Natural Areas Inventory
1018 Thomasville Road, Suite 200-C
Tallahassee, FL 32303
phone: (850) 224-8207 x 212
fax: (850) 681-9364
e-mail: djackson@fnai.org

f. NatureServe Contact

Nancy Benton, Project Manager
NatureServe
1101 Wilson Blvd., 15th Floor
Arlington, VA 22209
phone: (703) 908-1886
fax: (703) 908-1917
e-mail: nancy_benton@natureserve.org

g. Expert Contacts

1. Experts on Florida Bog Frog

David C. Bishop *
Department of Fisheries and Wildlife Sciences
Virginia Polytechnic Institute and State University
Blacksburg, VA 24061
phone: (540) 231-5320
fax: (540) 231-7580
e-mail: dabishop@vt.edu

* Bishop is examining the ecology of the species for his Ph.D. dissertation. During field season, he can be contacted through Bruce Hagedorn (see section 4.c).

Paul E. Moler *
Florida Fish and Wildlife Conservation Commission
4005 S. Main St.
Gainesville, FL 32601
phone: (352) 955-2230
fax: (352) 376-5359
e-mail: paul.moler@fwc.state.fl.us

* Moler discovered and described the species.

David J. Printiss *
The Nature Conservancy
Northwest Florida Program
P.O. Box 393
Bristol, FL 32321
phone: (850) 643-2756
fax: (850) 643-5246
e-mail: dprintiss@tnc.org

* Printiss conducted 1998 distributional survey for the species.

2 Experts in Southeastern U.S. Amphibian Biology

Mark Bailey *
Conservation Services Southeast
2040 Old Federal Road
Shorter, AL 36075
phone: (334) 727-2040
fax: (334) 727-1005
e-mail: mbailey@conservationsoutheast.com

* Bailey has particular expertise with the gopher frog and tiger salamander.

Dr. C. Kenneth Dodd, Jr. *
USGS/Florida Integrated Science Centers
7920 NW 71st Street
Gainesville, FL 32653
phone: (352) 264-3507
fax: (352) 378-4956
e-mail: ken_dodd@usgs.gov

* Dodd has extensive experience with Southeastern salamanders and other herpetofauna.

Richard Franz *
Florida Museum of Natural History
University of Florida

Gainesville, FL 32611
phone: (352) 392-1721 x 474
fax: (352) 846-0287
email: dfranz@flmnh.ufl.edu

* Franz has studied Florida herpetofauna, including gopher frogs, for three decades and is familiar with Eglin Air Force Base.

Margaret S. Gunzberger *
Department of Biological Science
Florida State University
Tallahassee, FL 32306-1100
phone: (850) 644-9820
fax: (850) 644-9829
e-mail: gunz@bio.fsu.edu

* Gunzberger is studying Florida frog ecology for her Ph.D. dissertation.

John Jensen *
Georgia Department of Natural Resources
Nongame-Endangered Wildlife Program
116 Rum Creek Drive
Forsythe, GA 31029
phone: 478-994-1438
fax: 478-993-3050
e-mail: John_Jensen@dnr.state.ga.us

* Jensen assisted Palis (below) with 1992-1994 studies of the gopher frog and flatwoods salamander on Eglin AFB.

Dr. Steve Johnson *
USGS/Florida Integrated Science Centers[a]
7920 NW 71st Street
Gainesville, FL 32653
phone: (352) 264-3507
fax: (352) 378-4956
e-mail: Steve_Johnson@usgs.gov

* Johnson completed his Ph.D. studies on striped newts at the University of Florida and now works with declining amphibians.
[a] soon transferring to the University of Florida

Linda LaClaire *
U.S. Fish and Wildlife Service
6578 Dogwood Valley Parkway, Suite A
Jackson, MS 39213
phone: (601) 321-1126

fax: (601) 965-4340
email: Linda_LaClaire@fws.gov

* LaClaire coordinates USFWS activities for listed amphibians in the Southeastern U.S.

Dr. D. Bruce Means *
Coastal Plains Institute and Land Conservancy
1313 Milton St.
Tallahassee, FL 32303
phone: (850) 681-6208
fax: (850) 681-6123
e-mail: means@bio.fsu.edu

* Means has studied salamanders on Eglin AFB since the 1960s.

John Palis *
P.O. Box 387
Jonesboro, IL 62952
phone: 618-833-3227
e-mail: jpalis@yahoo.com

* Palis conducted studies of the gopher frog and flatwoods salamander on Eglin AFB from 1992-1994.

h. Additional Stakeholder Contacts and Interests

1. Conservation Partners

The following organizations may have or have already expressed an interest in conservation of the bog frog or its habitat. For each, the name and address of the most pertinent contact are provided.

Florida Division of Forestry (DOF) *
attn: Justin Wilson, Regional Biologist
Tates Hell State Forest/
290 Airport Road
Carabelle, FL 32322
phone: (850) 697-3734 x 116
fax: (850) 697-2892
e-mail: wilsonj1@doacs.state.fl.us

* DOF co-sponsored the 2002 Yellow River Ravines Florida Forever proposal (see section 6.c.2) and is recommended as potential manager of lands that are acquired through this program

Florida Fish and Wildlife Conservation Commission (FFWCC) *
attn: Paul E. Moler (see section 4.g.1)

* the FFWCC assists the Eglin AFB Natural Resources Branch (NRB) in the review and development of management plans and provides technical information and support of its fish and wildlife management program. Eglin has been part of the FFWCC's Type II Management Area Program for more than 20 years. As such, the FFWCC provides fish and wildlife law enforcement support from its Wildlife Officers.

Florida Forever Program (State of Florida) *
attn: Dr. O. Greg Brock
Division of State Lands
Office of Environmental Services
3900 Commonwealth Blvd.
Mail Station #140
Tallahassee, FL 32399-3000
phone: (850) 245-2784
fax: (850) 245-2786
e-mail: Greg.Brock@dep.state.fl.us

* The State of Florida has under consideration for protection the Yellow River Ravines Florida Forever Project (see section 6.c.2).

Gulf Coastal Plain Ecosystem Partnership (GCPEP)*
attn: Vernon Compton, GCPEP Project Director
attn: JJ Bachant Brown, Conservation Ecologist
4025 Highway 178
Jay, FL 32565
phone: 850-675-5760
fax: 850-675-5756
e-mail: gcpep@bellsouth.net

* This partnership formed in 1996 to promote conservation of biodiversity within a one million-acre region of the East Gulf Coastal Plain Ecoregion. The partnership includes the U.S. Department of Defense, Florida Department of Environmental Protection, Florida Division of Forestry, International Paper, National Forests in Alabama, Nokuse Plantation, Northwest Florida Water Management District, and The Nature Conservancy.

The Nature Conservancy (TNC) *
attn: Richard Hilsenbeck, Callie DeHaven
625 North Adams St.
Tallahassee, FL 32301
phone: (850) 222-0199
fax: (850) 222 0973

e-mail: rhilsenbeck@tnc.org, cdehaven@tnc.org

* TNC co-sponsored the 2002 Yellow River Ravines Florida Forever proposal (see section 6.c.2).

2. Landowners and Managers

Three occurrences of the bog frog are on private land north of Eglin AFB. Figure 1 depicts land ownership boundaries based on the 2002 Santa Rosa County plat book. The known frog sites occur along a power line right-of-way that crosses the three streams.

Gulf Power Co. (GPC)*
Robin Finkel
1 Energy Place
Pensacola, FL 32520
phone: (850) 444-6536
fax: (850) 444-6217
e-mail: rifinkel@southernco.com

* GPC maintains the habitat along the power line right-of-way (ROW). Plans are to herbicide the ROW during 2004.

International Paper (IP)*
David Whitehouse, Region Wildlife Program Manager
P.O. Box 6002
Ridgeland, MS 39158
phone: (601) 605-1224
fax: (601) 605-1222
e-mail: david.whitehouse@ipaper.com

Mike Davidson, local land manager
4025 Highway 178
Jay, Florida 32565
phone: (850) 675-0929 x 113
fax: (850) 675-0938
e-mail: mike.davidson@ipaper.com

* IP owns two of the three sites occurring on private lands and is cooperating with the state in securing protection of the land via the Florida Forever program (see section 6.c.2). IP has enrolled the lands with GCPEP (above).

The third privately owned site (Burnt Grocery Creek) has multiple owners (see section 6.c.2; IP owns much of the drainage below the known bog frog site). Conservation interest is unknown

but probably limited. The preferred option is to incorporate these parcels into the Yellow River Ravines Florida Forever Project (section 6.c.2).

5. SPECIES INFORMATION:

a. Species Description

Rana okaloosae is described in detail by Moler (1985a). Additional information and photographs are provided by Ashton and Ashton (1988; note photographic error below), Bartlett and Bartlett (1999), Conant and Collins (1991), Hipes *et al.* (2001), and Moler (1985b, 1992, 1993).

The Florida bog frog is a small, yellow-green to brown ranid frog that normally lacks spots (Fig. 2), although subtle spotting is present in some individuals. Body (snout-urostyle) length excluding the legs is 3.5 – 5.3 cm (1.5 to 2 inches), which makes this the smallest North American ranid frog. On each side of the back is a light dorsolateral ridge that starts behind the eye but which does not reach the groin. The skin of the upper surfaces bears numerous low tubercles that give the frog a somewhat warty rather than smooth appearance. Scattered light spots are on the lower jaw, lower sides, and outer abdomen, and the belly has dark worm-like markings. The tympanum (eardrum) is flat in both sexes, brown, and two-thirds of, to slightly larger than, the diameter of the eye. The upper lip is greenish yellow, the throat yellowish, and the eye coppery. Webbing between the toes of the hind feet is extremely reduced, with the pointed toes extending well beyond the webbing (at least three phalanges of fourth toe, and at least two phalanges of all others, free of web; Fig. 2). Males are slightly smaller than females in mean size, have somewhat swollen thumbs, proportionately larger tympana, and a pair of external vocal sacs (not internal as previously reported) that can be partially inflated by applying slight pressure to the abdomen (Bishop, 2004). The advertisement call is a series of 3-21 guttural chucks that slow noticeably toward the end of the series; single chucks are sometimes issued. The voice has relatively limited carrying power.

The tadpole is slender with an elongate tail. General coloration is olive brown, with numerous buff spots on the tail, and white spots on the belly. The last characteristic helps to distinguish this species from the often syntopic bronze frog, *R. clamitans*. Although many bronze frog tadpoles also have white spots on the belly, those of the bog frog tend to be better separated and on a darker (blacker) background; however, young tadpoles of the two species can be difficult to distinguish (D. Bishop, pers. comm.). Additional morphological characters are provided by Moler (1985a).

Photographs or illustrations of the bog frog may be found in Moler (1985a,b,1992, 1993), Stone (1986), Carmichael and Williams (1991), Conant and Collins (1991), Bartlett and Bartlett (1999), Hipes *et al.* (2001), and U.S. Air Force (2002). Ashton and Ashton (1988) provide color photographs of an egg mass and tadpole, although their depiction of a frog actually represents a species other than *R. okaloosae* (Moler , 1993). Moler (1985a, 1993) provides illustrations and photographs of the tadpole, detailed drawings of its oral disc, and audiospectrograms of the advertisement call.

Similar Species: All other ranid frogs within the southeastern U.S. are larger than 5 cm in body length except when very young. The bullfrog (*R. catesbeiana*), pig frog (*R. grylio*), and river frog (*R. heckscheri*) lack dorsolateral ridges. The bronze frog, which is common along Florida streams and co-occurs with *R. okaloosae*, is distinguished by the raised center on the tympanum of males. All four species have more extensively webbed hind feet, with toes extending little or not at all beyond the webbing (no more than two phalanges of fourth toe of bronze frog free of web).

Figure 2. Photographs of the Florida bog frog, *Rana okaloosae*. Top, adult; bottom, detail of hind foot showing reduced webbing. Photographs by David J. Printiss.

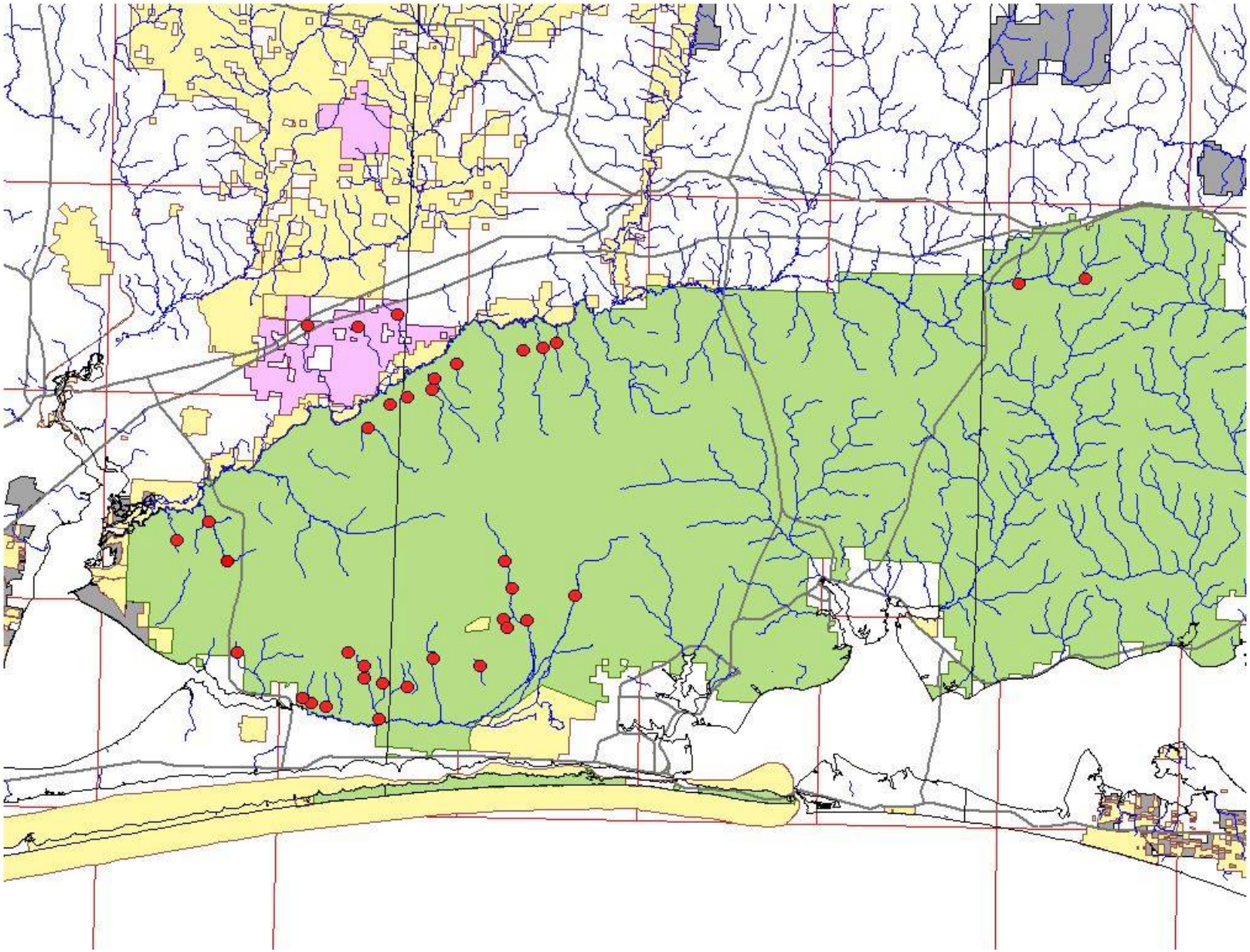
b. Distribution

In his surveys that led to the species' description, Moler (1985a) identified 15 localities for the bog frog; he had increased this to 23 by 1993 (Moler, 1993). Printiss (Printiss and Hipes, 1999), as part of a 1997-1998 survey for rare herpetofauna on Eglin AFB, discovered 12 additional occurrences and extended the frog's known distribution southward by 2.3 km. Enge (2002) added an additional site (upper Weaver Creek) during a 1998-1999 survey of seepage habitats in Okaloosa and Santa Rosa counties. Since 2001, Bishop (2004) has increased the total number of known locations to 57, although most of the additions are simply extensions of previously known sites (i.e., within the same tributaries); however, one represents a previously undocumented tributary (Prairie Creek) for the species. The increase in the number of known sites reflects heightened survey efforts and greater awareness of the species. As such, it is expected that additional sites will be discovered as surveys continue, although only the discovery of populations in previously undocumented drainages or streams would be especially notable. Bishop currently maintains a database to track the results (both positive and negative) of all bog frog surveys, which will continue during the 2004 activity season. Data for known localities, as recorded in the FNAI data base, are summarized in Appendix 2.

Current data indicate that the bog frog is endemic to a small, three-county area of western Florida (Fig. 3). Most known localities occur in contiguous southeastern Santa Rosa County and southwestern Okaloosa County, with two outliers approximately 30 km to the east in west-central Walton County. All localities lie within the Yellow and East Bay river drainages (both part of the Pensacola Bay hydrological basin). The eastern outlying sites are tributaries of Titi Creek and represent the only known occurrences within the Shoal River portion of the Yellow River drainage. For purposes of this document, all occurrences are hereafter assigned to one of three metapopulations – Yellow River, East Bay River, or Titi Creek. Elevations at known sites range from approximately 5 feet along the lower East Bay River floodplain, to more than 150 feet along upper Titi Creek. Despite the close proximity of tributaries of the Choctawhatchee and Blackwater river systems to known sites, the species has yet to be found in either drainage.

All but three localities occur on Eglin Air Force Base. The remaining three are situated on private land just north of the base (Fig. 3) in Santa Rosa County near the Okaloosa County line (see section 6.c.2, Regional Conservation Actions). The three non-DOD sites are the only ones known from the northern side of the Yellow River; the creeks in which they are situated lie directly across the river from other inhabited streams on Eglin AFB.

Fig. 3. Map of known localities (red dots) of the Florida bog frog, *Rana okaloosae*, as represented by element occurrence records in the Florida Natural Areas Inventory database. Additional recently identified sites in the same tributaries and general vicinities (Bishop, 2004) are not depicted separately. Green, Eglin Air Force Base; yellow, other public lands; pink, Yellow River Ravines Florida Forever project (see section 6.c.2); gray, other Florida Forever projects.



c. Habitat

The bog frog occupies a variety of microhabitats that share several features. Most sites are clear, shallow, non-stagnant, acidic (pH 4.1 - 5.5) seeps and seepage streams that arise via the percolation of water through the coarse soils of the surrounding sandy uplands (principally Lakeland-Troupe series: Moler, 1985a). In areas of lower relief, these seepages may overflow or broaden into boggy but still shallow, non-flowing areas that often support sphagnum moss (*Sphagnum* sp.), black titi (*Cliftonia monophylla*), and occasionally white cedar (*Chamaecyparis thyoides*). Printiss and Hipes (1999) characterized the vegetational layers at bog frog sites as follows: canopy sparse, with swamp tupelo (*Nyssa biflora*), Atlantic white cedar, and slash pine (*Pinus elliottii*); sub-canopy sparse to moderately dense, dominated by small canopy trees and large titi; shrub layer sparse, dominated by titi and St. Johns wort (*Hypericum* spp.); and herb layer lush, diverse, dominated by pitcherplants (*Sarracenia* spp.), sundews (*Drosera* spp.), graminoids (grass-like plants), and often large mats of sphagnum. The generally moderate to high levels of insolation (sunlight penetration) at many bog frog sites is at least in part an effect of periodic fires limiting or retarding hardwood encroachment , especially in the subcanopy and shrub layers (see section 6. Species Conservation Issues for management implications of this). At the non-DOD sites, it is at least in part a consequence of the maintenance of a broad power line right-of-way (ROW), although frogs at one site (Garnier Creek) occur just north of the ROW in a dense stand of white cedar with a sparse subcanopy and shrub layer and sphagnaceous herb layer. A fairly dense canopy is also present at Enge's (2002) upper Weaver Creek site. Even though Bishop (pers. comm.) has found the species in some fully shaded areas, his impression is that frogs are more abundant (and possibly larger) in sunnier sites.

Although surveys to date suggest that the conditions described above represent the primary habitat signatures for the bog frog, it should not be assumed, without extensive additional effort, that the species can not occupy other microhabitats. However, present knowledge suggests it to be unlikely that the frog can maintain viable populations in habitats in which seepage does not play a role.

Depending upon the distribution of appropriate microhabitat, frogs may occur from the headwaters of streams downstream to their confluence with larger streams or river floodplains. Frogs are known from isolated seepages as well as from seepage areas that occur along the upland edges of floodplains (Moler, 1985a; Printiss and Hipes, 1999; Bishop, 2004).

Although alteration of stream habitats appears often to be detrimental to bog frogs, it does not necessarily extirpate (though it may fragment) local populations. At least one site lies immediately below a small impoundment (Roberts Pond), and three sites are in cleared power line rights-of-way. Nonetheless, the species seems to disappear from or decline in impounded sections of streams, probably as a result of loss of the very shallow rivulet microhabitat that normally occurs along the margins of small seepage streams (see section 6.b.3).

Potentially suitable habitat can be identified by use of topographic maps and aerial photographs as viewed in ArcView. However, ground-truthing is necessary to determine whether microhabitat conditions at identified sites are appropriate for the species. Habitat that appears to be suitable for bog frogs is moderately common on Eglin AFB (roughly 150 km of streams and

floodplain edge as cursorily determined from 1:100,000 topographic map). Its availability, therefore, is not considered limiting to the species' long-term viability as long as it can be retained and managed (section 6.b) appropriately.

d. Life History

The bog frog is a resident of seepage habitats year-round, although its inactivity during cold weather makes it nearly impossible to find during the winter (except for tadpoles). Based on male calling activity and observations of eggs, the breeding season extends from March to September (Bishop, 2004; Moler, 1992). Males typically call from shallow water surrounded by sphagnum (Moler, 1992, 1993). Oviposition (and development) sites are characterized as small, shallow, non-stagnant seepage rivulets (Moler, 1985a; Printiss and Hipes, 1999). From <100 to several hundred eggs are laid in a thin gelatinous mass on the surface of the water; eggs may or may not be attached to vegetation or debris (Ashton and Ashton, 1988: see photograph; Bartlett and Bartlett, 1999; Bishop, 2004). Eggs can be observed in gravid females by shining a light through the abdominal region (Bishop, 2004). Tadpoles apparently overwinter and transform into tiny frogs (< 2.5 cm) the following spring or summer (Moler, 1985a).

Bishop (2004) is currently investigating the mating system and communication of the bog frog. Results will be published in his Ph.D. dissertation. His early studies have revealed that the calling sites selected by males are often the same sites at which females deposit their egg masses. Males produce three types of calls, including single chucks in addition to the serial chucks of the advertisement call; females occasionally make chucking calls as well. Males may father zero, one, or several clutches within a breeding season. By calling several nights, males improve their opportunities for reproductive success. Males respond to taped playbacks of calls but do so less on rainy nights. Bishop's dissertation will present analyses of male spacing patterns and the roles of various calls.

Because of their kinship and co-occurrence in many sites, it is not surprising that the bog frog and bronze frog (*R. clamitans*) have been reported to hybridize (Moler, 1992, 1993; Bishop, 2004). Hybridization is common between many congeneric frogs, however, and rarely seems to present any threats to species integrity, nor is there any strong reason to suspect it will be to the bog frog (P. Moler, pers. comm.); the two species presumably have cohabited for thousands of years. Still, it would be of interest to determine the abundance, microdistribution, and fertility of the reputed hybrids.

Bishop (2004) is also examining home range and movements along linear stream corridors. Frogs (mostly males) are captured, toe-clipped, and released, and positions of subsequent recaptures are recorded. Although probably exceptional, one frog did move a short distance overland from a stream to a cypress dome. Nonetheless, genetic exchange among frogs occupying different tributary streams is more likely to occur as a result of movements along common floodplains between the lower ends of the streams. The potential contribution to dispersal and gene exchange of in-stream movements of tadpoles is unknown and in need of study.

Population structure, abundance, carrying capacity, and survival rates have not yet been determined for the bog frog. Bishop's dissertation will present data for three field seasons at one study site, but longer term research and monitoring will be needed to determine such parameters and their variability. As an interim measure, it is suggested that a minimum viable (local) population for the species is indicated at a site by the presence of multiple calling males and documented presence of either one or more adult females or at least one dozen tadpoles (need not all be on the same date) in each of at least two years during a five-year period.

Little is known of predation on the bog frog. Bishop (2003) documented predation on tadpoles by the southern (banded) water snake (*Nerodia fasciata*), which is also likely to prey on juvenile and adult bog frogs. The cottonmouth (*Agkistrodon piscivorus*) is common within the bog frog's habitat and represents another potential predator (P. Moler, pers. comm.). Feral hogs potentially consume frogs, which are possibly vulnerable when inactive in winter retreats, although data on this aspect of life history are unknown.

e. Populations

Species conservation efforts generally focus on maintaining or increasing the size of populations, or at least limiting their rates of decline. Because of the recency of discovery of the bog frog, and the primary necessity of determining the species' distribution, there are as yet no rangewide data on its population size or population trends. About 90% of known sites occur on Eglin AFB, and it is likely that the base supports a comparable or even higher percentage of the species' total population.

Population data are very difficult to obtain for a relatively cryptic species such as the bog frog. Such methods as calling surveys and the capture, mark, and release of frogs (April-September) are necessary. Additional surveys for numbers of egg masses and tadpoles are helpful but may be of little use in quantifying population sizes because of incompleteness. Extensive survey effort would be required to begin to obtain such data rangewide. David Bishop's studies are focusing on obtaining such information in one relatively small stretch of a single inhabited stream. Even when his data are available, it will be difficult to gauge how representative they may be of populations in other sites, even nearby ones. Any attempt to address carrying capacity for this species is premature at present.

Defining a population for the bog frog is also difficult. Bishop (pers. comm.) does not yet feel able to do so after several years of study. It is not known how many adult frogs are necessary for a local population to remain viable (minimum viable population size, or mvp). Whereas a population consisting of hundreds of individuals might be considered robust, some sites undoubtedly are persisting with far fewer individuals, though the lower limit is unknown. For management purposes, it is logical to consider all frogs within a single tributary stream system, or along a continuous floodplain edge, as representing a local population or conservation unit (herein termed Conservation Management Unit, or CMU; see section 6.a.1, Conservation Objectives), although this should not be confused with defining them as a population in the sense of population genetics. CMUs within relatively discrete drainages or watersheds can then be

grouped as “metapopulations,” the conservation of which is now considered to be critical to the preservation of biodiversity. Metapopulations for the bog frog are designated in section 6.a.

Fortunately, in the case of the bog frog, good population data are probably not needed to manage and conserve the species. Rather, its conservation can be effected by a program that includes 1) monitoring all sites annually to biennially to assure that bog frogs are present, showing signs of reproduction/recruitment, and not exhibiting obvious declines or unusual mortality, and 2) managing habitat and threats at all sites appropriately (below).

To date, no known bog frog populations are known to have been extirpated, although some are known to have declined or been fragmented as a result of flooding of seepage habitats (see section 6.b.3). Therefore, this management document does not address restoration of populations at historical locations.

f. Survey Methodology

The most efficient method of surveying for the presence of bog frogs is the use of nocturnal auditory surveys during the activity season. Frogs call predominantly from May through August, and sporadically as early as March (D. Bishop, pers. comm.) and as late as September. Appropriate habitat (seepage streams and seepages along floodplains) is identified from topographic maps in conjunction with field reconnaissance. Males will call in response to taped playback of calls. In contrast to most frogs, calling activity is reduced during and for several days following heavy rains (Bishop, 2004). If bog frogs are present and active, they often can be heard calling within 2-3 minutes (Printiss and Hipes, 1999). Nonetheless, because of the sporadic nature of calling, a site should be visited for at least one half hour on five different nights before assuming that bog frogs are probably absent. Whether a night is appropriate for auditory surveys can be determined by first visiting a site(s) at which bog frogs are known; if none are calling, surveying other potential sites should be deferred (Printiss and Hipes, 1999). The surveyor should record number of calls (and estimated number of individuals) heard in a given time period in addition to noting pertinent non-biological data (e.g., time, air temperature, and precipitation).

Species presence can also be determined by dipnetting to capture tadpoles, although young tadpoles especially can be confused with those of the bronze frog (see section 5.a), which occurs microsympatrically with the bog frog. Although more labor-intensive and not providing data on adult population size (i.e., estimated number of calling males), this method does provide positive confirmation of successful breeding if larvae are found.

Frogs can also be captured by hand or with a dipnet, although their cryptic pattern and behavior may limit success. The placement of drift fences in conjunction with funnel traps in appropriate habitat can also document the presence of bog frogs (Enge, 2002), although the relative efficiency of this technique is low. Nonetheless, it can be a useful tool if part of a more general herpetological survey.

6. SPECIES CONSERVATION:

a. Conservation Strategy and Objectives

Because the bog frog occupies such a limited global range, conservation must focus on protecting as much habitat as possible (elaborated below) for the species. The species should remain viable as long as its present distribution is retained; i.e., no restocking or population enhancement is needed under present circumstances. However, habitat management activities are needed to increase local population sizes and availability of optimal habitat.

1. Underlying Conservation Strategy

An absolute minimal goal for the species' conservation must be the protection of a series of populations representing each of the three metapopulations (East Bay River, Yellow River, and Titi Creek) recognized herein. This is necessary to ensure conservation of any currently existing genetic variability (as yet unstudied) and to prevent random, naturally occurring factors from precipitating demographic collapse. Although not studied in bog frogs or closely related species, conservation theory predicts that species that have been extirpated from much of their range and/or declined substantially in population size (with concomitant loss of genetic diversity), or which naturally have very small ranges or population sizes, may experience the accumulation of deleterious alleles that ultimately result in severe population declines and eventual extinction. In order for such species to survive or recover in the future, all the genetic diversity across the total range of the species must be conserved in order to provide the species with adaptive abilities should future environments change (Culotta, 1995; Lande, 1988,1995; Lynch *et al.* 1995). Based on potential genetic differences, as well as simply the extra buffer that spatial dispersion offers against stochastic events, all three metapopulations of the bog frog are, therefore, considered necessary for the survival of the species and recovery from any future declines.

Watersheds are used as a basis for this conservation strategy, as they are natural units of the landscape, and because if there is important genetic heterogeneity in bog frogs, it is likely to follow watershed boundaries (overland movements between drainages are virtually non-existent so far as known).

2. Conservation Objectives

Two major categories of action are key to achieving success for the above strategy. Of paramount importance is managing bog frog habitat on Eglin AFB in an ecologically sound manner in order to achieve optimal conditions for the species. With more than 90% of the known range lying within the boundaries of Eglin AFB, the ultimate fate of the species rests with the Department of Defense. Every effort should be made to protect and manage all seepage stream and floodplain habitats, in conjunction with adjacent uplands, that are known to or which might support the species. Because most of these habitats are not directly used for DOD mission activities (but see section 6.b.6), this is a

feasible goal that could be accomplished with sufficient commitment and dedication of resources.

Of secondary importance, every effort should be made to protect all three stream systems known to support the frog on private (non-DOD) lands, as these presently are the only sites known from north of the Yellow River (but see section 7.b.1 regarding need for additional surveys). This will require acquisition or less-than-fee simple protection of land followed by ecologically sound management. Section 6.c.2 addresses current efforts to achieve this objective.

To assist managers in setting priorities for these actions, known localities for the species have been consolidated into Conservation Management Units (CMU; Table 1). Generally, a CMU represents a river floodplain or a stream system that flows into a floodplain. A CMU includes all bog frog localities within such a system, as well as other habitat that might support the species but which may not yet have been surveyed. Based on this classification, conservation priorities for all CMUs are assigned as Very High (1), High (2), Medium (3), or Low (4) (Table 1). Priorities are assigned principally on the basis of 1) size of available habitat (rough estimate of km of stream/floodplain length) as a surrogate for estimated bog frog population size, 2) contribution to geographic representation (e.g., drainage and disjunction), or 3) data indicating a reliable, sizable population. Protection should focus on entire stream systems (i.e., the CMUs), not just known bog frog sites. Table 2 summarizes priority assignments for all CMUs (Eglin AFB and off-site) by major drainage.

Protection (including appropriate habitat management) of all Very High priority CMUs (rank 1) is critical to meeting the overlying objective of conserving all three metapopulations of the Florida bog frog. This category encompasses 12 CMUs: four streams and the floodplain within the East Bay River system, five creeks and the floodplain within the Yellow River system, and the entire upper Titi Creek system. Protection of High priority CMUs (rank 2) is likewise considered integral to maintaining metapopulation dynamics and long-term viability, as these sites likely are very important reservoirs for the species as well as potentially provide additional genetic diversity. This category encompasses one additional stream in the East Bay River system, and six in the Yellow River system. Future distributional surveys (see section 7.b.1) may identify other CMUs that should subsequently be assigned to one of these two categories.

In conjunction with protecting the identified CMUs, management should also focus on maintaining continuity of appropriate riparian habitat (see section 5.c) among them to prevent habitat fragmentation and isolation of local populations (see section 6.b.8). The latter are considered by conservationists to be among the gravest threats faced today by many species (Culotta, 1995; Lande, 1988,1995; Lynch *et al.*, 1995). Section 6.c.1 addresses current DOD actions focusing on this objective. In this regard, it is important to protect the floodplains of lower Titi Creek and the Shoal River, as these serve as the only wetland connection between the potentially disjunct upper Titi Creek CMU and the Yellow River proper.

Table 1. Conservation Management Units (FNAI occurrence numbers from Appendix 2) and Conservation Priorities for the Florida bog frog.
Priorities (1, very high; 2, high, 3, medium; 4, low) are assigned principally on the basis of 1) size of available habitat as a surrogate for estimated population size, 2) contribution to geographic representation (e.g., drainage and disjunction), or 3) data indicating a reliable, sizable population. Protection should focus on entire stream systems, not just known bog frog sites.

Drainage/CMU	Conservation Priority
East Bay River	
Dean Creek (7)	1
East Bay River floodplain and Swamp (22, 23, 24, 25, 27)	1
Horse Branch (20)	3
Live Oak Creek and Swamp (17, 19, 26, 32, 33)	1
Panther Creek (25, 29, 30, 31)	1
Prairie Creek (34)	2
Turtle Creek (18)	1
unnamed creek east of Panther Creek (28)	3
Titi Creek	
upper Titi Creek (15, 16)	1
Yellow River	
North Side – private (Yellow River Ravines Florida Forever project)	
Burnt Grocery Creek (14)	2
Garnier Creek (13)	1
Julian Mill Creek (12)	2
South Side – Eglin AFB	
Camp Creek (21)	2
Carroll Creek (11)	2
Crane Branch (5)	2
Hicks Creek (8)	2
Malone Creek (1)	1
Milligan Creek (3)	1
unnamed seepage creek, west of Milligan Creek (4)	2
unnamed creek east of Malone Creek (10)	3
unnamed creek east of Metts Creek (2)	4
Weaver Creek (9, 35)	1
Wolf Creek (6)	1
Yellow River floodplain (mouths of 5, 6, 8, 9, probably many other sites)	1

Table 2. Summary of recommended conservation priorities by drainage and Conservation Management Unit, based on Table 1.

	East Bay River	*Titi Creek*	*Yellow River*
Very High (1)	floodplain and Swamp Dean Creek Live Oak Creek and Swamp Panther Creek Turtle Creek	upper Titi Creek (all)	floodplain Garnier Creek[a] Malone Creek Milligan Creek Weaver Creek Wolf Creek
High (2)	Prairie Creek		Burnt Grocery Creek[a] Camp Creek Carroll Creek Crane Branch Hicks Creek Julian Mill Creek[a]
Medium (3)	Horse Branch unnamed creek E of Panther Creek		unnamed creek E of Crane Branch unnamed creek E of Malone Creek
Low (4)			unnamed creek E of Metts Creek

[a] stream located on private lands north of Eglin AFB

b. Threats and Management Solutions

Because the Bog frog is unknown to most people and has little economic value, known threats to the species principally revolve around degradation of its environment. Printiss and Hipes (1999) and Enge (2002) reviewed the most obvious of such threats. In this section, an attempt is made to list known and potential threats in perceived level of importance, from most widespread or serious to least, although this order should not be considered sacrosanct, and future data might suggest its modification. Each threat category is followed by one or more management options or solutions.

Threats and management options and solutions differ little between occurrences of the bog frog on DOD and non-DOD (private) lands. They are, therefore, treated together in this section, with annotations specifically addressing any differences as appropriate. The scope and time frame of this project did not allow in-depth analysis of threats and management needs at all known bog frog localities. Nonetheless, site-specific threats and recommended management actions are included in Appendix 2 as they were noted during field examination of known occurrences. A

partial list of sites exhibiting various threats or in need of management attention is also included below (Table 3 at end of this section) for each of several categories of threat.

Priorities for habitat management activities should follow the CMU priorities presented in Table 2. Management actions should not be limited to known bog frog sites but rather extended throughout entire CMUs as needed. Some threats are most likely to occur at known bog frog sites (e.g., erosion at road crossings), whereas others (e.g., extensive woody encroachment) may occur within parts of CMUs that have not been surveyed due to difficulty of access.

1. Fire Suppression and Habitat Succession

Threats:
Fire plays a role in the maintenance of bog frog habitat. During dry periods, fires that naturally burn the uplands above seepage habitats would have swept downslope into shrub bog habitats. This would have eliminated or retarded the growth of shrubs and trees, which tend to invade these habitats in the absence of fire (Means and Moler, 1979). The reduction of insolation as a result of increased shading appears to reduce or eliminate local populations of such species as bog frogs and pitcherplants, which require at least some sunny areas. Increased density of woody species may also reduce soil moisture as well as the amount of shallow rivulet habitat preferred by the bog frog. In streams where the riparian vegetation consists predominantly of mature hardwood species, bog frogs typically occur only at disturbed (sunnier) sites such as at power line right-of-way crossings (Moler, 1992 and pers. comm.). Their absence from densely shaded sites is attested to by the results of auditory surveys (P. Moler, pers. observ.; D. Printiss, pers. observ.). Because of the recency of discovery of the species and the need to focus field work on basic distributional surveys rather than monitoring, data documenting local population extirpation related to woody encroachment and excessive shading are not available. Such extirpation probably occurs on a time-scale that equals or exceeds the time since the species discovery (ca. 20 years).

Although quantitative data on historic vs. current availability of suitable bog frog microhabitat are unavailable, present conditions suggest a long-term downward trend as a result of replacement of massive historic fires (often during drought) by more recent patterns of fire exclusion and controlled prescribed fires. The relictual presence of heliophilic plants (e.g., pitcherplants, *Sarracenia* spp.) in overgrown, shaded habitats along several bog frog streams attests to a pattern of woody plant encroachment that has continued to occur in recent decades.

Management Options and Solutions:
Where appropriate, management should attempt to maintain a relatively open shrub bog community (see Means and Moler, 1979). Although data for bog frogs are insufficient to permit quantification, a minimum of 20% of ground surface receiving some direct sunlight seems reasonable. This should secondarily benefit other rare species (e.g., panhandle lily [*Lilium iridollae*], sweet pitcherplant [*Sarracenia rubra*], and pine barrens treefrog [*Hyla andersonii*]) that thrive in this habitat. Prescribed fire is the principal tool to achieve this, and it is currently used extensively (and laudably) at Eglin AFB. Many of

the sites observed during 2004 nonetheless suffered from woody plant encroachment, and it was clear that recent fires rarely burned into the riparian zone. Fire managers should be encouraged to take such steps as they deem appropriate to achieving a more open riparian understory. The following paragraph offers possible tools for their consideration.

Although there may be increased risk associated with burning during dry periods, this would facilitate habitat maintenance and improvement for the frog. Fire managers could perhaps take advantage of directional winds to burn downslope into riparian zones when conditions permit. Growing season burns are generally preferable in associated upland habitats and can be expected to produce hotter fires that have increased chances of burning into riparian vegetation. If high fuel loads in adjacent uplands prohibit hot, growing season or wind-driven fires, managers might consider burning a "black line" upslope (along or above the upper edge of the riparian-upland ecotone) during less threatening conditions (P. Moler, communication, in Printiss and Hipes, 1999); the riparian zone would later be burned while fuels remained low within the black line. This should decrease the risk (of catastrophic or undesired fire in uplands) from igniting hot fires aimed at burning the riparian zone. In extreme cases, it may be appropriate (though labor intensive) to cut larger woody species along the riparian edge, then follow this with a burn after the slash has dried; burning a black line above the burn zone may again help to decrease risk to upland communities.

In summary, existing management at Eglin AFB should continue its present use of prescribed fires but attempt to increase their coverage, frequency, intensity, and effectiveness (by pushing them into riparian zones). In some instances (where fire will not carry or where smoke may be a problem for the Eglin mission), the use of mechanized equipment may be considered as a potential replacement for fire, though great care must be used to avoid undue soil and groundcover disturbance. Non-Eglin lands will require extensive remedial actions to restore fire-maintained communities; these may include harvesting of timber followed by reforestation with longleaf pine, mechanical cutting of shrubs, introduction of prescribed fire, and possibly the judicious use of herbicides (but only after thorough testing for effects on non-target species). Table 2 identifies priorities by CMU for such actions, although on-the-ground field inspection will be necessary to identify specific sites in greatest management need.

2. Erosion, Siltation, and Flooding (Roads and Borrow Pits)

Threats:
Roads that cross or run along the edges of seepage streams have several potentially negative effects on bog frog habitat. Among these are siltation and flooding. With 1930 km of streams on base (U.S. Air Force, 2002), it is not surprising that many of Eglin's unpaved range roads cut directly across one or more streams, including most of those inhabited by bog frogs. Base-wide, 286 known erosion sites on Eglin account for an estimated 90,000 tons of annual soil loss (U.S. Air Force, 2002). Especially in the steeper terrains of the Yellow River drainages, tons of soil and water rush downhill along or on roads directly into known bog frog sites during heavy rains. Eglin has attempted to stem the tide of runoff at some sites by paving stretches of road and constructing water

diversion channels. Results appear to be mixed. While the road crossings themselves are less likely to be washed out, large erosional gullies have formed on both sides of some roads, and deltas of sediment provide clear testimony to the continuing erosional deposition that accompanies precipitation. Flooding is naturally rare in the stable seepage stream ecosystem; in addition to unnatural and sudden increases in depth, it is also accompanied by pronounced changes in current velocity and water temperature. It is uncertain how such events (even though temporary) may affect bog frogs. Because eggs are laid and tadpoles develop in very shallow rivulets, it is likely that such flooding is deleterious if not disastrous to reproduction (Printiss and Hipes, 1999).

The construction of borrow pits from which clay is extracted for roadfill on Eglin AFB has likewise contributed to siltation and flooding at some sites. The walls of at least one pit have collapsed, with the result that tons of sediments entered and virtually blocked a seepage stream (Camp Creek, FNAI occurrence 21) known to support bog frogs. Frogs no longer occur in the impounded area but have been heard above it.

It should be noted that in at least some sites that have been heavily impacted by siltation, bog frog populations seem to be maintaining themselves (at least at present). Nonetheless, continued siltation of these sites might eventually make them unsuitable, perhaps by filling in the shallow rivulet microhabitat or favoring the development of a single, deep channel that replaces the broader, shallow one.

Management Options and Solutions:
Maintaining naturally vegetated slopes and uplands above riparian habitats used by bog frogs is the key to preventing erosion and siltation. Ideally, from an ecological perspective, roads contributing to soil erosion in seepage habitats should be closed; those considered important for traffic movement should be rerouted farther upslope. Where this is not practical, immediate actions should be taken to revegetate barren road shoulders and to fill and revegetate erosional gullies. Construction of additional water diversion turnouts may be helpful, but these must be monitored to assure that they themselves do not become erosional channels. Paving of road crossings may be helpful in reducing siltation, but only if adjacent road shoulder areas are well vegetated. Sites in need of erosion control actions are identified in Appendix 2; Eglin AFB reportedly has plans to re-route at least one road that crosses a small seepage stream (Appendix 2: FNAI occurrence 4; P. Moler, pers. comm.).

International Paper, the Florida Department of Transportation, and GCPEP, have initiated an effort to reduce runoff and siltation from the large gully on Julian Mill Creek (non-DOD land). In addition to the emplacement of hay bales, the project has begun to revegetate the slopes. This effort (and similar efforts elsewhere as needed) should continue. Special attention should be given in such projects to using species that occur naturally in local shrub bog habitats. If hay bales or potted plants are used, they should be certified as weed-free, as well as inspected to be sure that they are free of fire ants.

Borrow pits located immediately upslope of any seepage habitat should be closed. Grading or reconstruction may be necessary to assure that such pits do not become

holding ponds that may rupture during large storms. Major revegetation efforts, using native vegetation as much as possible, should be undertaken and include the reestablishment of a grassy groundcover in addition to shrub and canopy layers. The construction of a series of contoured catch basins below borrow pits also seems to be an effective means of rehabilitation (Enge, 2002). The closure and/or management of borrow pits within the range of the bog frog could be conducted as an extension of, and using knowledge gained from, similar restoration work that has been undertaken on Eglin AFB on behalf of the Okaloosa darter during the last 10 years.

3. Impoundment

Threats:
Impoundment of seepage streams may be deliberate or unintentional. It is common practice in western Florida for landowners to build small dams to impound portions of small seepage streams to provide recreation (especially fishing for stocked game fish) as well as a water supply. The resulting flooding typically eliminates or at least fragments local populations of animals, such as the bog frog, that require streamside microhabitats. Not only does impoundment flood the shallow riffle habitat preferred by adults bog frogs, but it also eliminates the freely moving, cooler, and more highly oxygenated waters that are probably required by the tadpoles.

On Eglin AFB, the negative effects of impoundment on bog frogs can be seen at Roberts Pond (a tributary of Live Oak Creek; FNAI occurrence 17), where bog frogs persist immediately below the dam. Similar damage may have occurred at Indigo Pond on Indigo Branch in the Titi Creek drainage (near FNAI occurrence 16). The collapse of a road crossing culvert has had a similar effect on Weaver Creek (FNAI occurrence 9), which Moler formerly considered to be the best known for the bog frog. Beaver dams, often created at artificial road crossings by plugging culverts, have likewise flooded bog frog habitat at several sites on Eglin (e.g., FNAI occurrences 4, 5, and 7), as did sediments from a collapsed borrow pit on Camp Creek (FNAI occurrence 21; previous section). In these cases, bog frogs now occur only above or below the impounded area. Nonetheless, it is premature to state that the relationship between bog frogs and beavers is entirely negative; it may be that in some instances beavers have created habitat for the frog (this requires study).

Although construction of additional impoundments can be prevented on Eglin AFB, there are few or no legal restrictions to assure that this will not occur on unprotected private lands, where three bog frog streams occur. This underscores the importance of bringing these private lands into public ownership or at least securing less-than-fee simple provisions to prevent impoundment (see section 6.c.2).

Finally, the potential threat to the bog frog and other seepage stream inhabitants from proposed impoundment of the Yellow River upstream of Eglin AFB should be noted. Although no known bog frog sites would be flooded, any drop in basal water levels within this system below the dam might affect seepage streams downstream, perhaps by increasing their head-cutting action (J. Herod, pers. comm.; J. Bachant Brown, pers.

comm.) or reducing the extent of shallow streamside rivulets.

Management Options and Solutions:
Under no circumstances should new impoundments be constructed along any stream inhabited by the bog frog. Unintentional impoundment, created by the blockage of culverts by debris or by beaver activity, as well as the collapse of culverts, can be reduced (though perhaps not eliminated) by installing large, cement box culverts rather than smaller, tubular metal culverts beneath roads that are deemed essential to retain for traffic movement. Beaver dams blocking streams recognized as being important to bog frogs can be physically removed, with trapping of beavers in areas of repeated blockages.

The Natural Resources Branch at Eglin AFB should carefully examine and monitor all proposals related to the damming of the Yellow River upstream. It would be especially pertinent to model potential effects this action might have on the base's seepage streams, both hydrologically and environmentally.

4. Invasive Non-Native Species

Several non-native species degrade bog frog habitat both on Eglin AFB and private lands. All of these require active control measures. Feral hogs directly damage the substrate and immediate microhabitat required by the frog, while a number of plants that grow aggressively in riparian zones have the potential to increase shading and thereby reduce the level of insolation (sunshine penetration) that typifies bog frog habitat. Fire ants, although present on the base and sometimes found within or near its wetlands, probably represent little threat to the frog, as water serves either as a habitat or refuge for all of the frog's life stages.

a. Hogs

Threats:
The seepage habitat of the Bog frog is especially vulnerable to disturbance by wild hogs. Printiss (pers. comm.) and Means (pers. comm.) both noted substantial hog damage to Eglin's seepage stream systems during herpetological studies in the 1990s. Eglin's INRMP summarizes the threat from hogs on the base as follows. "The wild hog or feral pig has been prioritized as the most problematic invasive non-native animal species that threatens natural ecosystems on Eglin. Wild hogs compete with native wildlife for food and alter natural habitats that are critical for both plants and animals. Wild hogs prey on many forms of native wildlife. The rooting of wild hogs in sensitive natural areas, such as seepage slopes and steephead ravines, has damaged and destroyed many rare and sensitive plants" (U.S. Air Force, 2002).

Management Options and Solutions:
Eglin's Natural Resources Branch (NRB) is responsible for addressing the threat to native ecosystems from wild hogs on the base. To provide greater flexibility for the control of feral hogs, Eglin AFB removed the "game species" status for hogs prior to the 1999-2000 hunting season. Nonetheless, despite there no longer being any size or bag limit for

harvesting hogs, the overall population has continued to increase, especially in areas where hunting is prohibited (on Eglin's "closed areas"). As stated in the INRMP, "wild hogs are extremely prolific. To achieve a declining population trend requires the removal of more than half the hog population on an annual basis." The NRB monitors the impacts of feral hogs on base (U.S. Air Force, 2002) and in October 2003 initiated a cooperative program with the U.S. Department of Agriculture that has already removed more than 200 hogs, principally from the closed areas. Although recent hog damage was not extensive at bog frog sites observed during early 2004 field examination, this can change quickly, and an aggressive approach to the control of hogs is appropriate.

b. Invasive Non-Native Plants

Threats:
Invasive plants are generally not abundant in bog frog habitat but do pose a potential threat of decreasing insolation (increasing shading) in the relatively open shrub bog habitats required by the species. The chief threat in riparian habitats in western Florida is Chinese tallow tree (*Sapium sebiferum*), a rapidly growing tree that easily establishes itself in sunny locations and which can develop into dense thickets. The species is ranked in Category I (highest management concern, known to alter native habitats) by the Florida Exotic Pest Plant Council (EPPC), a non-profit organization made up of public agencies, scientists, researchers, land managers, environmental organizations, and private citizens. Chinese tallow trees have been documented on approximately 200 acres and 20 known sites on Eglin property. The species has been introduced to Eglin property by past landscaping practices, illegal dumping of landscape debris, and seed dispersal by birds from adjacent privately owned property (U.S. Air Force, 2002). A second woody species also with the potential to degrade bog frog habitats is Chinese privet (*Ligustrum sinensis*; EPPC Category I).

Shading can also develop in such habitats beneath large tangles of Japanese climbing fern (*Lygodium japonicum*; EPPC Category I: see below), a rapidly growing vine that can cover and smother understory and mid-story plants. The species is spread by wind-blown spores and is difficult to control. Approximately 10 acres at five sites have been documented on Eglin property.

Other species that might present threats to bog frog habitats include the trees Chinaberry (*Melia azedarach*) and mimosa (*Albizia julibrissin*), air-potato (*Dioscorea bulbifera*, a rapidly growing vine that can cover trees and shrubs), and torpedo grass (*Panicum repens*). Cogon grass (*Imperata cylindrica*) may invade the adjacent uplands and power line rights-of-way. All are ranked in Category I by the EPPC.

Management Options and Solutions:
Every effort should be made to eliminate any infestation of invasive exotic plant species growing in bog frog habitat. Guidelines for removal and control of a given species can be obtained from the Florida Exotic Pest Plant Council (http://www.fleppc.org), the Florida Department of Environmental Protection's Bureau of Invasive Plant Management, and the University of Florida's Center for Aquatic and Invasive Plants. All

herbicides should be used with extreme caution in and around aquatic habitats, especially those that support rare amphibians. If plants are to be removed physically, extreme care should be taken to avoid impacts that might cause siltation or damage the soft substrate and delicate vegetation in such habitats.

Since 1999, approximately 155 acres of Chinese tallow tree on Eglin AFB have been treated with Garlon 4 and JLB Oil Plus adjuvant and are on a retreatment schedule. The remaining untreated acreage is to be placed on a treatment schedule as funds become available. When areas are treated for Chinese tallow, all other invasive non-native woody species are treated as they are encountered. All known Japanese climbing fern sites have been treated with herbicide and are being monitored. (U.S. Air Force, 2002).

5. Pollution

Threats:
Surface water quality of streams inhabited by the bog frog on Eglin AFB is considered intermediate or high (U.S. Air Force, 2002: fig. 3-9). Nonetheless, and although their effects on bog frog populations are unknown, pollutants do enter at least some of the streams inhabited by the species. Two of the three streams occurring on private land (Burnt Grocery, Julian Mill creeks) have their headwaters just below US-90 and pass beneath I-10; both likely receive petrochemical runoff as a result. The threat is likely most severe in Julian Mill Creek, where a very large gully has eroded below the interstate and enters the creek. Most of the streams supporting frogs on Eglin AFB are crossed by range roads and are therefore subject to introduction of some petrochemical pollutants. Potential input is probably greater in streams along the south side of the Yellow River, where steeper terrain leads to rapid channeling of runoff either via erosive gullies or directly along the roads themselves. Live Oak Creek crosses a major test range and may possibly be subject to the introduction of pollutants as a result.

A second form of pollution is the introduction of herbicides. Gulf Power uses herbicides to reduce or eliminate shrubs and trees along the power line right-of-way that cuts across the three privately owned bog frog streams; a 2004 application is currently planned. Eglin AFB cooperates with Gulf Power in allowing similar herbicide applications to rights-of-way on the base (although precautions are taken), where at least two cross known bog frog streams (Dean Creek and Live Oak Creek). No data address the effect of herbicide use on the bog frog.

Livestock (horses?) were observed grazing upslope from the Burnt Grocery Creek site. Although they did not have access to the stream and were separated from it by abundant vegetation, it is possible that livestock waste might have some, though probably minimal, effect on the stream's water quality.

Management Options and Solutions:
Efforts to eliminate or control erosion (see section 6.a.2) are also key to preventing pollutants, such as petrochemicals from vehicles, from entering bog frog streams via runoff. Water quality should be monitored at sites where erosion is substantial, or below

points that cross military test ranges, to determine whether corrective actions are needed.

Any herbicide to be used in or near bog frog habitat should be reviewed for potential effects on non-target organisms. Effects on amphibians, including their larval stages, should be examined. Laboratory studies to test potential effects specifically on bog frogs and their tadpoles should be conducted. Bog frog populations inhabiting streams that are subject to the introduction of herbicides should be closely monitored before and after local application of herbicides. Although Eglin AFB policy restricts the use of herbicides to uplands, and herbicides in use are believed to break down quickly in the soil, it would nonetheless be appropriate to monitor seepage streams as a precaution to assure that no leaching of herbicides is occurring.

If proven safe, the use of herbicides may be preferable to the physical clearing of vegetation, which likely would disturb groundcover vegetation and soils and lead to erosion, siltation, and introduction of petrochemicals. However, until research provides such information, the use of herbicides in bog frog habitat should be viewed with extreme caution. Mowing (bush-hogging) may present a safer alternative if done carefully; mowing in winter is less likely to disturb frogs, although it should be avoided when soils are soggy to reduce the risk of soil and groundcover degradation.

Elimination of livestock from slopes above bog frog streams may not be necessary but nonetheless would be a wise precaution. Any erosional features draining from slopes occupied by livestock should be filled and revegetated.

6. Impacts of Military Training and Testing

Threats:
Because of the bog frog's restriction to seepage habitats, direct impacts of Eglin's military training and testing missions appear to be limited. Most such activities take place in the base's upland habitats. Nonetheless, the construction and placement of roads and other facilities upslope from or through bog frog habitats has led to habitat degradation through factors listed above (e.g., erosion, siltation, pollution). A significant portion of one very high priority CMU, Live Oak Creek, crosses a major military test range. Because of restricted access, it is not known whether frogs occur there or whether military activities have impacted the habitat.

Management Options and Solutions:
Avoidance of bog frog habitats for infrastructural development and military missions and training should remain a primary focus of bog frog conservation efforts on Eglin AFB. It is imperative to preclude to the greatest extent possible the movement of vehicles and troops through sensitive seepage habitats, as they are so easily disturbed. This requires more of a continuation of current Eglin policies than any real change, as existing protective measures based on cultural and wetlands issues are already in place. The base's current operational plan acknowledges the importance of seepage habitats, which should support bog frog conservation and recovery. The ignition of fires in Eglin's wildlands as a result of military activities is a positive factor in terms of maintaining bog

frog habitat and, from an ecological perspective, need not be restricted or controlled.

Surveys of the portion of upper Live Oak Creek that crosses the test range should be conducted as feasible. These should assess the potential presence of bog frogs as well as habitat conditions and threats. It is especially important to assure that downstream portions of Live Oak Creek are not degraded by pollution or siltation that might result from test range activities (including vehicular movements).

7. Silvicultural Operations

Threats:
Replacement of the native upland longleaf pine forest ecosystem by intensively managed sand pine plantations has many consequences for rare as well as common species. Although directly leading to the decline or extirpation of native upland species, secondary effects on downslope (wetland) species is possible. The foremost threat to bog frog habitat is the exclusion of fire from such plantations, with the consequences elaborated above (section 6.b.1). The loss of native groundcover may affect the rate of percolation of rainfall, the slow release of which is the driving force that regulates seepage streams such as that required by the bog frog. Silvicultural operations also increase the potential for siltation of seepage streams as the result of ground disturbance during harvest operations. In some instances, insecticides and herbicides may be introduced. Invasive plants are also more prone to establishment in disturbed environments.

Management options and solutions:
Preferred management is eventual replacement of sand pine plantations with fire-maintained natural communities dominated by longleaf pine and native grasses. Sand pine should be harvested (by careful clear-cutting) with special attention given to minimizing soil disturbance, especially near the riparian-upland ecotone. Restoration will require massive revegetation with native upland species.

8. Habitat Fragmentation

Threats:
Habitat fragmentation is a major conservation threat to most species, as human degradation and destruction of natural landcovers have isolated individuals and local populations that once maintained gene flow across relatively continuous ranges. At present, this would seem to be a minor threat to the bog frog; it is included here as a potential threat that sound ecological management can prevent from becoming important. No data are available concerning the viability of small, isolated populations of bog frogs, but it is inherently logical that continuity with a larger source pool of frogs can only be beneficial in reducing the chances of local extirpations, as well as in allowing repopulation of habitats that might have lost bog frogs for some reason. Although patterns of movements of bog frogs among various occupied tributaries are unknown, the most parsimonious hypothesis is that such movements, which may occur only infrequently, are along stream corridors and via common floodplains at the lower ends of

tributaries, rather than across upland ridges situated between tributaries (Bishop [2004] did record one individual movement upslope, but this is likely rare). It is worth noting that excessive woody encroachment along seepage streams can potentially act as a mechanism that isolates localized frog populations even along the same tributary.

Management Options and Solutions:
Management should focus on maintaining natural riparian habitat (as described in section 5.c) along the entire lengths of tributaries, from sites of known occurrences of bog frogs downstream to their confluence with riverine floodplains. As discussed above (section 6.a.1), allowing (or encouraging) fires to burn into riparian zones, by burning under appropriate weather conditions, can reduce the opportunity for woody vegetation to isolate frogs inhabiting different sections of the same tributary. Floodplain riparian zones should be maintained intact and free of high-intensity timber harvesting.

9. Hybridization

As mentioned elsewhere (section 5.d), genetic swamping or alteration through hybridization with the bronze frog is not presently deemed to be a threat to the bog frog, despite reports of hybridization in the wild (D. Bishop, pers. comm..; P. Moler, pers. comm.). The topic is included within this list of threats only as a precaution that merits monitoring and study (see section 7.b.2).

10. Other Potential Threats

Since the 1970s, unusual declines of amphibians, especially frogs, have been reported worldwide (Alford and Richards, 1999). These have prompted hundreds of studies in search of causative agents (e.g., Lanoo, in press), as well as dedicated organizations such as the Declining Amphibian Populations Task Force (DAPTF) and U.S. Geological Survey Amphibian Research and Monitoring Initiative (ARMI). Several symposia and their resulting proceedings have shed light on the subject, while also raising questions and suggesting directions for future research. Some of the factors believed to be partially responsible for such declines are noted below. Nothing is known about the relevance of these to the bog frog (which is not known to be declining), but they merit long-term consideration in any amphibian conservation program and, therefore, are included here.

a. Disease and Parasites

Threats:
An association between amphibian declines and pathogens and/or parasites is now widely accepted. One suspected causative agent of global concern is chytrid fungus, which is known to be associated with many declining populations of frogs, especially species that breed in streams (Bonaccorso *et al.*, 2003, and references therein). However, chytrid fungus is also present in some seemingly healthy populations (Hopkins and Channing, 2003), so conclusions are not yet definitive. Bacterial and viral infections also pose potential threats. At least some populations of anurans (frogs and toads) are thought to have disappeared as a result of bacterial infection (Carey, 1993; Davis and Gregory,

2003).

A variety of trematodes (flukes) and nematodes (roundworms) are known from frogs, but rarely are their effects on host populations understood. In general, it is known that parasites may affect the growth and survival of individual hosts, and it is suspected that they may be able to regulate host population sizes (Kehr and Hamann, 2003, and references therein). Johnson *et al.* (1999, 2001) identified a parasitic fluke as the probable cause of malformation (e.g., excess limbs) in some species of North American frogs; such anomalies likely reduce the survivorship and fitness of individuals.

Management Options and Solutions:
Although control or treatment of pathogens and parasites may be difficult within infected local populations, it is important to prevent the spread of such agents among populations. Recommendations for anyone working within aquatic habitats that support breeding populations of amphibians are to disinfect appropriate clothing (e.g., boots, waders, shoes) and equipment (e.g., dipnets, seines, funnel traps) whenever moving between sites. A 10% solution of bleach has been suggested as adequate.

Monitoring is also important. Any signs of mortality, disease, or abnormal individuals should be recorded. If three or more such individual frogs or toads are observed at a local site, they should be preserved in 70% ethyl alcohol with their bellies slit to facilitate preservation. Specimens can later be provided to appropriate researchers for examination.

b. Physical/Climatological Environmental Factors

Threats:
Tremendous concern and attention are being directed globally toward changes in the physical and climatological environments that may be resulting from human disturbances to the environment. These issues are far too complex to treat in this document. Among the factors of concern are climatological change (including global warming and precipitation patterns), acid precipitation, and increased levels of ultraviolet radiation.

One potential long-term change that may affect the bog frog's distribution is the increase in sea level that is expected to accompany global warming (as a result of the melting of polar ice caps and glaciers). Because the bog frog inhabits low-elevation streams (with some sites along the lower East Bay River being little more than 5 feet above sea level), habitat may be lost as the lower portions of streams are flooded with saline water.

Management Options and Solutions:
Global environmental and climatological issues occur at a scale far beyond that for which management can be directed toward the bog frog alone. Rather, all persons, agencies, and organizations should support national and global efforts to ameliorate the potential threats posed by the factors noted above.

Table 3. Partial list of known bog frog sites in need of management attention.
Listed by FNAI occurrence number (Appendix 2) within CMU priority categories (Tables 1, 2). * = non-DOD sites. Sites shown in bold are considered in high need of attention. This listing should not be considered definitive; additions and modifications should be made in the future as indicated by detailed field assessments.

CMU Priority Management Recommendation	**Notes**	**1**	**2**	**3**	**4**
reduce woody invasion of riparian zone (burn if possible)	nearly all sites in need	**1**, 3, **7**, 9, 18, 19, **22**, **24**, **25**, 27, 29, 30	4, 5, 6, 11, 12*, 21	10, 28	2
road closure or rerouting		27	**4**		
erosion/road crossing evaluation and management		1, **3**, 15, 16, 17, 18, 19, 25, 26, 27, 31	5, 6, 8, 11, 12*, 13*, 14*, 21	10, 20, 28	2
borrow pit closure, repair, or restoration		**31, 33**	**12***, **21**		
beaver dam removal		**7**	**4**, **5**		
culvert clearing, repair, or replacement		**7**, **9**			
impoundment removal, restoration:		15, 17			
hogs: eradicate wherever sign is noted; include sites		17	**4**		
invasive plants	no critical sites noted; eradicate wherever discovered				
power lines: monitor streams for residual herbicide and unusual mortality following application		7, 9, 32	12*, 13*, 14*		
monitor military impacts		upstream of 17, 19, 26, 32, 33			
restore plantation to native upland pine community			12*, 13*, 14*		

c. Conservation Actions: Adaptive Management and Monitoring

1. DOD Conservation Actions

The Eglin AFB NRB has proactively designated the bog frog as a conservation target in its INRMP. As such, it has initiated actions toward the species' conservation, as well as outlined potential future actions (Appendix 1). The effectiveness of future management (and quantity of resources) directed toward the bog frog on Eglin AFB can be enhanced by a continued or increased level of cooperation with potential conservation partners (see section 4.h.1).

Included within its current and recent efforts directed toward the species are support of research into the ecology and distribution of the species, most specifically through Virginia Polytechnic Institute and State University (Bishop, 2004) and the Florida Natural Areas Inventory (Printiss and Hipes, 1999). Continued studies of these types will prove invaluable in conserving the species and its habitat.

Section 6.b of this document provides management recommendations to alleviate or limit known and potential threats to bog frogs on the base. One difficulty in managing the species on Eglin is the occurrence of several populations in areas of restricted access along the East Bay River. Special arrangements should be made to identify opportunities for periods of access to these areas that will be sufficient to inventory and monitor local populations and to identify management needs, as well as to conduct management activities.

Eglin AFB maintains an active program of prescribed burning in its uplands, with particular emphasis on maintaining or restoring habitat for the red-cockaded woodpecker. The current goal is to burn 70,000 acres per year. Greater emphasis at present is on increasing the frequency of fires, with less emphasis on seasonality (burns are conducted from December through June). A program to increase the coverage and frequency of fires on Eglin is compatible with bog frog conservation, with increased emphasis on burning into wetlands and riparian zones (as opposed to exclusion of fire from such areas, historically a common practice in Florida).

Eglin already has an active program addressing erosion control and the management of range roads (U.S. Air Force, 2002: 82-83; attached as Appendix 3). Stream sections that are receiving the most sediment receive the highest priority for action. However, streams with significant conservation targets (such as the bog frog) are eligible for more immediate action than those that have lower biodiversity value. At present, this program is driven primarily by conservation of the Okaloosa darter, the range of which is completely non-overlapping with the bog frog. Expansion of this program into the range of the bog frog would be highly appropriate.

Eglin has instituted management activities to address the threat from invasive non-native species (U.S. Air Force, 2002:109). As elaborated in section 6.b.4.b, management

activities most important to the bog frog are removal of hogs and elimination of Chinese tallow tree and Japanese climbing fern.

As part of its resource management program, the Eglin Natural Resources Branch (NRB) has established a large series of terrestrial and aquatic stations (monitoring plots) to determine the response of conservation targets (including the bog frog) to management actions. These include a number of tributaries that support the bog frog (U.S. Air Force, 2002: fig. 4-5).

Also, following a precedent on some military and government lands, Eglin AFB designated 15 areas as having special significance to conservation. These "Special Natural Areas (SNA's)," which are intended to represent and protect the best examples of major plant communities and habitat types within the Eglin Reservation, will be protected from most forest management activities (excluding restoration), some types of public access, and certain mission activities. They will also serve as reference sites for long-term ecological research and monitoring to assess impacts from various forms of management and mission activities as part of Eglin's adaptive management program. The SNAs include substantial stretches of two important bog frog streams, Weaver Creek (Yellow River) and Live Oak Creek (East Bay River) (U.S. Air Force, 2002: fig. 4-7).

2. Regional Conservation Actions (non-DOD lands)

Only three of the known occurrences of the bog frog are situated outside of Eglin AFB. These are in three adjacent tributaries flowing into the north side of the Yellow River (Eglin is on the south) near the community of Floridale. From east to west, the streams are Julian Mill Creek, Garnier Creek, and Burnt Grocery Creek. All three rise in the vicinity of the I-10/US-90 transportation corridor, where it passes between Eglin AFB and Blackwater River State Forest. The land encompassing the three streams has been proposed more than once for acquisition under the state's land acquisition programs.

In 1989, the Florida Natural Areas Inventory proposed protecting the bog frog sites through the state's Conservation and Recreation Lands program as part of a Blackwater-Eglin Connector project. Later renamed the Yellow River Ravines, the proposal was eventually approved and added to the state's Preservation 2000 project list from 1993-1996; it was removed in 1997 with the understanding that a state agency had it on its internal P-2000 list. In May 2002, The Nature Conservancy and the Florida Division of Forestry jointly submitted a modified Yellow River Ravines proposal (The Nature Conservancy and the Florida Division of Forestry, 2002) to the Florida Forever program. This proposal, which included all three bog frog streams, was approved by the Acquisition and Restoration Council (ARC) in June 2002 for re-addition to the state project list as a Group A/Full Fee Priority project. In refining the project's boundaries to include only willing sellers, the state removed one section of land that supported the bog frog site on upper Burnt Grocery Creek (but frogs might occur downstream on lands still within the project). The project, as depicted in the program's 2003 five-year plan (Florida Department of Environmental Protection 2003; see Appendix 4), includes 16,652 acres in 41 parcels held by five owners, with an estimated tax assessed value of $12,227,546. More than 90% of the project is owned by International Paper.

Negotiations to secure these lands are underway, with assistance from The Nature Conservancy; if successful, acquisition could occur as soon as late 2004 or early 2005. (Note: the Florida Department of Environmental Protection's Division of State Lands maintains an internet web site for the Florida Forever Program. This site contains a complete version of the five-year plan, which includes the Yellow River Ravines project on pp. 444-446).

If successful in acquiring the project, the state intends to assign its management to the Florida Division of Forestry (DOF) within the Department of Agriculture and Consumer Services. The land would then become part of Blackwater River State Forest (at 189,600 acres, already one of Florida's largest state forests). Blackwater Forestry Center personnel would carry out management activities and coordinate public access and use, as well as seek input and assistance from other agencies (e.g., FFWCC) and interested parties (e.g., GCPEP). The stated goals of DOF for managing such lands are "to restore, maintain and protect in perpetuity all native ecosystems; to integrate compatible human use; and to insure long-term viability of populations and species considered rare" (Florida Department of Environmental Protection, 2003). Such an ecosystem approach is highly compatible with bog frog conservation. The project also provides a key link in the protection of a continuous corridor of public land from Eglin AFB through Blackwater River State Forest and the adjacent Conecuh National Forest in Alabama.

The Yellow River Ravines project is crossed by a roughly east-west utility corridor that will require monitoring for unauthorized use (e.g., off-road vehicles) and introduction of invasive exotic species (e.g., Chinese tallow). The sites from which bog frogs are known within the Yellow River Ravines were discovered at the points at which the corridor crosses each of the three creeks, although it is expected that the occurrences extend along each stream.

The uplands within the Yellow River Ravines predominantly supported a sandhill natural community at one time, but intensive silviculture has severely degraded the resources. Initial management costs necessary to restore and manage this system as a state forest are, therefore, expected to be high. Groundcover restoration as well as reforestation in longleaf pine will be necessary. Costs should eventually decline to a moderate level as management emphasis shifts to habitat maintenance.

Both Julian Mill and Burnt Grocery creeks flow beneath Interstate 10 through concrete box culverts. Design flaws appear to have altered stream characteristics and induced sedimentation at these crossings. Pollutant-laden runoff and eroded sediments enter the streams from the highway during rain events, with consequent increases in turbidity as well as potential toxins to aquatic life. Preservation of these two stream ecosystems may require retrofitting of the highway crossings and drainage structures. If not acquired for conservation, water resources within the Yellow River Ravines project face potential threats from stream impoundment, sedimentation from improper silvicultural practices and road development and maintenance, and pollution and eutrophication from the use of

fertilizers and pesticides as well as septic tank discharge should development occur (The Nature Conservancy and the Florida Division of Forestry, 2002).

The Yellow River Ravines project excludes the section of land (sec 20, T2N, R26W) through which upper Burnt Grocery Creek passes, including the site of the known bog frog occurrence. In conjunction with preparation of this Management Guidance Document, the author identified four parcels of undeveloped land totaling 383.6 ac that should be considered for addition to the project. This was called to the attention of the Florida Forever program/DEP Division of State Lands, the Florida Division of Forestry, and The Nature Conservancy. Appendix 5 provides a map and parcel information.

d. Measuring Effectiveness of Conservation Actions

Conservation actions will be considered successful when the following criteria have been met.

1. Non-DOD Lands

a) Thorough distributional surveys for the bog frog have been completed in all potential habitats off-base (see section 7.b.1). Should the species be found in previously unknown locations, a plan will be delineated to assure that this habitat is managed and protected accordingly, and actions will be undertaken to instigate this plan. Failure to document the frog during each of three visits under appropriate climatic and seasonal conditions will be considered adequate sampling effort to support its probable absence from a site.

b) The State of Florida or a conservation partner has acquired or permanently protected by via less-than-fee simple measures private lands that encompass at least 90% of the mainstems of Burnt Grocery, Garnier, and Julian Mill creeks. This criterion could be fulfilled by securing the Yellow River Ravines Florida Forever project as well as additional lands recommended in section 6.c.2.
1) Perpetual management of these lands is assigned to a natural resource agency or organization, and a land management plan that focuses on the maintenance and restoration of natural habitats considered appropriate for bog frogs is written, approved, and instigated.
2) Measures have been put in place that permanently limit erosion, siltation, and pollution of these three streams, and culverts of sufficient size are in place that allow waters of Burnt Grocery and Julian Mill creeks to pass unimpeded beneath highways.

2. DOD Lands

a) Thorough distributional surveys for the bog frog have been completed in all potential habitats on Eglin AFB (see section 7.b.1). Should the species be found in previously unknown locations, the sites will be assigned to a CMU and ranked by priority (see section 6.a.2). Failure to document the frog during each of three visits under appropriate climatic and seasonal conditions will be considered adequate sampling effort to support its probable absence from a site.

b) All CMUs for the bog frog have been field-evaluated for existing and potential threats, both at known bog frog sites as well as at a sample of additional sites throughout the system (these could be pre-determined randomly, then visited; number of sites may range from three to 10 depending on system size). Data will be incorporated into Table 3. Efforts to accomplish this task will focus on CMUs in Priority order (1-2-3).

c) Sufficient and appropriate management actions, as outlined in section 6.b, have been undertaken so as to ameliorate identified and potential threats to bog frog habitat in all Priority 1 and 2 CMUs, with emphasis on sites known to be inhabited by the species (including any identified subsequent to the preparation of this document). Actions may include, but not be restricted to, the following:
1) reduce excessively dense, woody vegetation in the riparian zone and adjacent ecotone and uplands, most often by fire but by other means if fire is precluded, yielding at least 10% penetration (preferably closer to 20%) of sunlight to ground/water surface of stream floodplain or seepage area;
2) eliminate sources of unnatural erosion, siltation, and pollution, eliminate risk from collapse of borrow pits;
3) eliminate or maintain impoundments so as to prevent further damage (including dam collapse);
4) eliminate or reduce hog levels to minimize disturbance to riparian zones;
5) eliminate invasive exotic plants; and
6) restore uplands adjacent to streams inhabited by bog frogs back to appropriate, fire-maintained upland natural communities, particularly longleaf pine-dominated sandhills (may require sand pine removal).

3. Bog Frog Populations

Bog frog populations at all known sites within High (1) and Very High (2) CMUs are determined to be viable, and none show signs of local extirpation. Local populations (at individual sites) will be considered viable if, during any five-year time frame, they exhibit both of the following characteristics:

a) multiple calling males heard on one or more nights during breeding season in at least three of five consecutive years; and
b) at least one adult female or at least one dozen tadpoles observed in at least three of five consecutive years

e. Impacts to Other Imperiled Species

1. Other state or federally listed species that may benefit from management actions discussed in this document

Control of erosion and potential pollution in the streams inhabited by bog frogs will likewise help to limit the amount of silt and pollutants that enters the Yellow/Shoal, and East Bay rivers. This should be beneficial for other listed aquatic species that inhabit these rivers. In particular,

the Yellow River is known to be inhabited by the Gulf sturgeon (*Acipenser oxyrinchus desotoi*: US Threatened , T; Florida Species of Special Concern, SSC), bluenose shiner (*Pteronotropis welaka*: FL SSC), and at least formerly, by the Gulf moccasinshell (*Medionidus penicillatus*: US Endangered, E). The alligator snapping turtle (*Macrochelys temminckii*: FL SSC) and American alligator (*Alligator mississippiensis*: FL SSC) inhabit both rivers. It should be noted that the bog frog's distribution is not presently known to overlap that of the Okaloosa darter (*Etheostoma okaloosae*: US and FL E), which is endemic to Choctawhatchee Bay drainages.

Regular burning of the uplands and slopes down and into streamside vegetation should be beneficial to other species that utilize these habitats. Seepage slope species include Baltzell's sedge (*Carex baltzelii*: FL T), spoon-leaved sundew (*Drosera intermedia*: FL T), panhandle lily (*Lilium iridollae*: FL E), white-top pitcherplant (*Sarracenia leucophylla*: FL E), sweet pitcherplant (*Sarracenia rubra*: FL T), Harper's yellow-eyed grass (*Xyris scabrifolia*: FL T), and pine barrens treefrog (*Hyla andersonii*: FL SSC). Upland species include hairy wild indigo (*Baptisia calycosa* var *villosa*: FL T), flatwoods salamander (*Ambystoma cingulatum*: US T, FL SSC), gopher frog (*Rana capito*: FL SSC), gopher tortoise (*Gopherus polyphemus*: FL SSC), eastern indigo snake (*Drymarchon couperi*: US T, FL T), Florida pine snake (*Pituophis melanoleucus mugitus*, FL SSC), and red-cockaded woodpecker (*Picoides borealis*: US E, FL SSC).

2. Other state or federally listed species that may be negatively impacted from management actions discussed in this document

It is unlikely that the proposed management actions will have deleterious effects on any listed species. Potential loss of some dense cover potentially used by the locally small population of black bears would likely be offset by other benefits to their resource base.

7. SPECIES RESEARCH

a. Current Research Programs

David Bishop, a graduate student at Virginia Polytechnic Institute and State University, is conducting ecological and behavioral studies of the bog frog for his Ph.D. Much of the life history information included within this document stems from his interim results (Bishop, 2004). Bishop plans to complete field work in August 2004, with submission of his dissertation scheduled for 2005. In conjunction with Dr. James Austin (Cornell University), Bishop is also attempting to confirm, through DNA analysis, the true nature of putative bog frog-bronze frog hybrids, preliminarily recognized as such based on calls and morphology. Upon completion of these studies, it would be appropriate to review this document to determine whether any modifications are needed.

b. Further Research Needs

Future research should focus on 1) expanding and refining knowledge of the bog frog's distribution, both across its range and within known sites; and 2) increasing understanding of the species' biology, its ecological requirements, and its responses to habitat management.

1. Distributional Surveys

Field work to delineate the distribution and extent of precise occurrences of the bog frog should continue. Off of Eglin AFB, surveys should be undertaken in the Blackwater River drainage. Although these may prove to be unproductive, the possible existence of undiscovered populations of the bog frog in this drainage can not be ruled out. The floodplains of the lower Yellow and Blackwater rivers lie within 8 km of each other, and both rivers empty into Blackwater Bay. Headwater tributaries of the two drainages come within roughly 2 km of each other in the vicinity of the known non-Eglin occurrences of the frog, although the drainages are separated by Interstate 10. Enge (2002) used drift fences and funnel traps to survey seepage streams in the Blackwater River drainage for one year, but this technique is less definitive for determining presence or absence of bog frogs than auditory surveys.

Further surveys on Eglin AFB, as well as a few offsite, have the potential to discover additional occurrences in tributaries not yet known to support the species. Special emphasis should be directed toward the eastern end of the range, particularly upper Titi Creek (the northern side especially), as well as Alaqua Creek and other tributaries of Choctawhatchee Bay. Printiss (Printiss and Hipes, 1999) failed to locate any additional occurrences in those regions, and it may be that the known sites in upper Titi Creek (which Printiss surveyed extensively) are truly disjunct from those located elsewhere. It is possible that the failure of researchers to identify additional populations in at least some of Eglin's creeks may reflect insufficient exploration of segments that are far from road crossings. Only after extensive additional and repeated survey work should it be assumed that stream systems currently not known to harbor bog frogs truly lack them throughout. Many such streams lie within the Yellow River drainage; a partial list of those that should be the subject of further investigation includes the following creeks, listed from west to east (i.e., ascending upstream) within drainage segment: Yellow River – Moore, Boiling, Bear, Metts, Middle, Turkey Gobbler, and Carr Spring Branch on the south (Eglin) side, and Canoe, Trawick, and Wilkinson on the north (private) side; Shoal River – Gopher, Turkey Hen, and Pearl; and Titi Creek – Silver, Honey, Blue Spring, Big Fork, and Gum. Nonetheless, Printiss (pers. comm.) surveyed numerous sites within most of these drainages without success.

It should also be emphasized that nearly all known occurrences represent only very small sections of streams where access was facilitated by road or power line crossings. Determination of the distributional limits and precise occurrences of bog frogs within all occupied wetland systems is desirable but would require extensive effort. For now, management must assume that frogs may potentially occur within appropriate habitat anywhere within an occupied system.

2. Ecological Studies

Even after the completion of Bishop's studies, additional data will be needed on age of maturity, population size, structure, and turnover at a variety of sites and in different years. Determining minimum numbers of individuals necessary for a local population to remain viable would be of great interest although difficult to ascertain. Further studies of movements, both of frogs and tadpoles, would provide valuable data about the species' potential for dispersal.

Degree of competition with the bronze frog should be examined, as should hybrid viability between the two species. The occurrence and abundance of hybrids (i.e., frequency within local populations) should be monitored to determine whether they are of ecological significance. Local populations where hybridization is suspected should be examined periodically (e.g., 3-year intervals) to determine the frequency of hybrids. This may necessitate the establishment and use of genetic markers, as attempting to assess this from auditory surveys is unlikely to produce adequate results.

It will be important to monitor the response of bog frogs to the various threats and management actions outlined in this report. The responses of frog populations to siltation, hogs, beavers, fire exclusion, pollution, use of herbicides, and other factors affecting microhabitat and water quality should be determined, as should responses to management efforts that improve negative conditions. It would be especially valuable to compare data on frogs (and tadpoles) before and following planned management actions. Local populations of the bog frog occurring in heavily silted sites should be monitored to determine whether continued siltation eventually makes the habitat unsuitable, or whether frogs continue to maintain viable populations.

8. INFORMATION MANAGEMENT

Several agencies and organizations, all listed in section 4, are managing information related to this species, and there is no reason why this should not continue. Because it has the responsibility for managing bog frog habitats on the Eglin reservation, it will be most effective for the Eglin Natural Resources Branch to maintain an in-house system to monitor and track such activities and their effects on the frogs' populations. Toward this end, D. Bishop and J. Mathers created an Access database of historical and presently known localities for the bog frog and other frog species; it was last updated in August 2003 and requires additional quality control, verification, and editing (D. Bishop, pers. comm., 2004). An electronic copy can be provided to appropriate agencies.

The Florida Natural Areas Inventory maintains a conservation database that includes mapped occurrences and supporting data (element occurrence records) for the bog frog. This can be expected to continue as a regular part of FNAI's mission. The database utilizes an ArcView-based GIS platform in conjunction with a data management system known as Biotics, developed for and overseen by NatureServe. FNAI, in conjunction with NatureServe, also maintains summary information about the species; these data can help to guide federal (USFWS) and state agencies (FWC) in making decisions regarding the species' status.

9. FEASIBILITY

a. Legal Authority

1. DOD

Legal authority for DOD conservation actions at Eglin AFB is provided under a ruling approved September 15, 1960, and commonly referred to as the "Sikes Act." The stated purpose of the act is "to promote effectual planning, development, maintenance, and coordination of wildlife, fish, and game conservation and rehabilitation in military reservations."

2. Non-DOD

The State of Florida has the legal authority to acquire and manage lands for conservation purposes through its Florida Forever Program. For specific details about this program, please see its Internet web site: http://www.dep.state.fl.us/lands/.

b. Time frame

Three (to a maximum of five) years (i.e., by the year 2008) should be sufficient to achieve most of the management recommendations in this document. This relatively short time frame is possible because 1) most of the necessary management programs (prescribed fire, erosion control, road maintenance, invasive species control) are already in place at Eglin AFB as a result of years of natural resource planning activity, and 2) the State of Florida and its private conservation partners have already initiated steps to secure protection of the majority of privately owned bog frog sites. However, implementation within this time frame may require more resources than currently are devoted to these programs.

It is recognized that moving fires into riparian zones along streams is difficult and depends upon favorable climatic conditions (e.g., drought). Thus, any time frame for this activity is extremely tentative. Nonetheless, this should be attempted with every major burn, with special emphasis during dry years. Ideally, substantial success at at least half of known sites will have been achieved within one decade.

A longer time frame, perhaps 10 years, is also necessary to conduct meaningful ecological studies. Monitoring programs to measure the effectiveness of habitat management on bog frog populations have no finite time frame but should become a regular part of each managing agency's programmatic activities.

c. Costs

1. DOD lands

Determining the cost of instigating specific management recommendations for the bog frog on Eglin AFB is not currently possible, as nearly all of the principal management actions (e.g., fire, erosion control, invasive species control) will involve reallocation of resources within existing management programs. Certainly, increases in funding to focus portions of these projects specifically on bog frog habitat would be desirable, as would the dedication of a NRB staff position (estimated $50,000 annually, including support) to rare amphibians (e.g., bog frog, gopher frog, pine barrens tree frog, flatwoods salamander, tiger salamander, and others).

2. Non-DOD lands

Estimated tax assessed value of the 16,652-acre Yellow River Ravines (YRR) project (see section 6.c.2) was $12,227,546 in 2002 (Florida Department of Environmental Protection, 2003). Actual offering price may vary from this. 2003 tax assessed value of the four parcels recommended in this document for addition to the project totaled $49,800, but it is probable that actual purchase price would substantially exceed this.

Should acquisition by the state be successful, interim management costs are estimated at $1,049,000 (salaries $164,000; expenses $375,000; operating capital outlay $510,000) (Florida Department of Environmental Protection, 2003; no time frame given).

3. Regional partners

The Florida Natural Areas Inventory can maintain basic element occurrence and supplementary data within its existing programs, although any additional dedicated funding (up to $5,000 annually) would allow it to focus specifically on bog frogs, which otherwise might be precluded by other priorities. Field survey work (by any organization or agency) to search for additional localities or to confirm continued existence of frogs at known sites would require specific funding related to the level of effort required. It is estimated that $15,000 to $25,000 per year would be appropriate.

d. Potential Funding Sources for Management Implementation

This section addresses potential funding sources to implement management prescriptions recommended in this document. Sources for DOD and non-DOD lands are considered separately in sections 1 and 2. Regional partners (section 3) may be able to assist in both instances.

1. DOD

Although the DOD Legacy Program has provided invaluable support in the past for natural resource work on Eglin, current guidelines do not favor projects focusing on single species or single installations. Nevertheless, even under such limitations, it may be possible to develop fundable proposals that revolve around a suite of rare amphibians that occur on multiple installations.

Many of the management actions espoused in this document are already encompassed by existing programs under the direction of or in conjunction with Eglin's Natural Resources Branch (NRB). However, several such programs are driven principally by a focus on listed species – e.g., upland pine management and prescribed fire for the red-cockaded woodpecker, and erosion control for the Okaloosa darter. Re-directing or expanding such programs to include Florida bog frog habitat should be feasible without a major increase in funding, although some increase in resources would undoubtedly be beneficial.

The NRB may be able to identify additional federal, state, or private programs that assist with stewardship actions on public lands. The U.S. Fish and Wildlife Service and Florida Natural Areas Inventory contacts for this project will direct such knowledge to NRB staff as they learn of them in the future.

The NRB's recent use of volunteers, universities, and conservation organizations to assist with amphibian surveys and studies is highly commendable and should be continued. In addition to the data provided, such programs provide an important means of educating and involving the public in species conservation as well as Eglin's role in protecting natural resources.

2. State of Florida

Funds for state acquisition of the Yellow River Ravines project would be provided through the state's Florida Forever Program. The Nature Conservancy may assist with negotiations and acquisition but is not expected to contribute any permanent funds. If the project is acquired, it is anticipated that management funding would come from the state's Conservation and Recreation Lands (CARL) trust fund.

3. Regional partners.

As stated above (section 9.c.3), the Florida Natural Areas Inventory will continue to maintain databases that include geographic records of occurrences and pertinent sources about the bog frog. Part of FNAI's basic database functions is funded through the state's Florida Forever Program; however, funding is insufficient to focus adequate attention on all of Florida's rare species, including the bog frog.

Like Eglin AFB, GCPEP recognizes the bog frog as one of its conservation targets. GCPEP staff therefore assist partners that have this species on their properties. However, no specific funds are dedicated toward the bog frog.

The Nature Conservancy is currently assisting with negotiations to protect IP lands within the Yellow River Ravines Florida Forever project. Whether TNC would maintain any role in the tract's long-term management is undetermined.

REFERENCES

Literature Cited

Alford, R. A., and S. J. Richards. 1999. Global amphibian declines: a problem in applied ecology. Ann. Rev. Ecol. Syst. 30:133-165.

Ashton, R. E., Jr., and P. S. Ashton. 1988. Handbook of reptiles and amphibians of Florida, part 3: The amphibians. Windward Publ., Inc., Miami, Florida.

Bartlett, R. D., and P. P. Bartlett. 1999. A field guide to Florida reptiles and amphibians. Gulf Publ. Co., Houston, Texas.

Bishop, D. C. 2003. *Rana okaloosae* (Florida bog frog): predation. Herpetol. Rev. 34:235.

____. 2004. Overview of Florida bog frog (*Rana okaloosae*) research. Unpublished report prepared for Florida Bog Frog Management Guidance Document planning team, 8 January 2004. 3 pp.

Bonaccorso, E., J. M. Guayasamin, D. Méndez, and R. Speare. 2003. Chytridiomycosis as a possible cause of population declines in *Atelopus cruciger* (Anura: Bufonidae). Herpetol. Rev. 34:331-334.

Carey, C. 1993. Hypothesis concerning the causes of the disappearance of boreal toads from the mountains of Colorado. Conserv. Biol. 7:355-362.

Carmichael, P., and W. Williams. 1991. Florida's fabulous reptiles and amphibians. World Wide Publications, Tampa, Florida.

Conant, R., and J. T. Collins. 1991. A field guide to reptiles and amphibians: eastern and central North America, third ed. Houghton Mifflin Co., Boston, Massachusetts.

Culotta, E. 1995. Minimum population grows larger. Science 270:32-32.

Davis, T. M., and P. T. Gregory. 2003. Decline and local extinction of the western toad, *Bufo boreas*, on southern Vancouver Island, British Columbia, Canada. Herpetol. Rev. 34:350-352.

Enge, K. M. 2002. Herpetofaunal drift-fence survey of steephead ravines and seepage bogs in the western Florida panhandle. Final Performance Report, Florida Fish and Wildlife Cons. Comm., Tallahassee. 66 pp.

Florida Department of Environmental Protection. 2003. Florida Forever Five Year Plan 2003. Florida Department of Environmental Protection, Division of State Lands. 467 pp.

Hipes, D., D. R. Jackson, K. NeSmith, D. Printiss, and K. Brandt. 2001. Field guide to the rare animals of Florida. Florida Natural Areas Inventory, Tallahassee.

Hopkins, S., and A. Channing. 2003. Chytrid fungus in Northern and Western Cape frog populations, South Africa. Herpetol. Rev. 34:334-336.

Johnson, P. T. J., K. B. Lunde, R. W. Haight, J. Bowerman, and A. R. Blaustein. 2001. *Ribeiroia ondatrae* (Trematoda: Digenea) infection induces severe limb malformations in western toads (*Bufo boreas*). Can. J. Zool. 79:370-379.

Johnson, P. T. J., K. B. Lunde, E. G. Ritchie, and A. E. Launer. 1999. The effect of trematode infection on amphibian limb development and survivorship. Science 284:802-804.

Kehr, A. I., and M. I. Hamann. 2003. Ecological aspects of parasitism in the tadpole of *Pseudis paradoxa* from Argentina. Herpetol. Rev. 34:336-341.

Lande, R.L. 1988. Genetics and demography in biological conservation. Science 24:1445-1460.

____. 1995. Mutation and conservation. Conservation Biology 9:782-791.

Lanoo, M. J. (ed.). In press. Status and Conservation of U.S. Amphibians.

Lynch, M., J. Conrey and R. Burger. 1995. Mutation accumulation and the extinction of small populations. American Naturalist 146:489-518.

Means, D. B., and P. E. Moler. 1979. The pine barrens treefrog: fire, seepage bogs, and management implications. Pp 77-83 in R. R. Odom and J. L. Landers (eds.), Proceedings of the Rare and Endangered Wildlife Symposium, August 3-4, 1978, Athens, Georgia. Technical Bulletin WL 4, Georgia Department of Natural Resources.

Moler, P. E. 1985a. A new species of frog (Ranidae: *Rana*) from northwestern Florida. Copeia 1985:379-383.

____. 1985b. Delicate balance. Species: Bog frog (*Rana okaloosae*). Florida Wildlife 39 (July-August):31.

____. 1992. Florida bog frog, *Rana okaloosae* Moler. Pp. 30-33 in P. E. Moler (ed.), Rare and endangered biota of Florida, vol. 3: Amphibians and reptiles. Univ. Press of Florida, Gainesville.

____. 1993. *Rana okaloosae* Moler. Florida bog frog. Catalogue of American Amphibians and Reptiles 561:1-3.

Printiss, D. J., and D. L. Hipes. 1999. Rare amphibian and reptile survey of Eglin Air Force Base, Florida. Final report to U.S. Dept. of Defense. Florida Natural Areas Inventory, Tallahassee.

Stone, L. M. 1986. "New" frog in the bog. Animal Kingdom 89(4):40-43.

Sutter, R. D., J. J. Bachant, D. R. Gordon, and A. R. Litt. 2001. An assessment of the desired future conditions for focal conservation targets on Eglin Air Force Base. Report to Natural Resources Division, Eglin Air Force Base, Niceville, Florida. The Nature Conservancy, Gainesville, Florida.

The Nature Conservancy and Florida Division of Forestry. 2002. Yellow River Ravines, Santa Rosa and Okaloosa counties, Florida. Florida Forever proposal submitted to Florida Department of Environmental Protection, Division of State Lands, Tallahassee.

U.S. Air Force. 2002. Integrated Natural Resources Management Plan, Eglin Air Force Base, FL, 2002-2006. U.S. Air Force.

Personal Communications

Bachant Brown, J. Gulf Coastal Plain Ecosystem Partnership, Jay, Florida. April 2004.

Bishop, David C. Virginia Polytechnic Institute and State University, Blacksburg, Virginia. January and March 2004.

Herod, Jeff. Natural Resources Branch, Eglin Air Force Base, Niceville, Florida. January 2004.

Means, D. Bruce. Coastal Plains Institute and Land Conservancy, Tallahassee, Florida. 2003.

Moler, Paul E. Florida Fish and Wildlife Conservation Commission, Gainesville, Florida. January – March 2004.

Printiss, David J. The Nature Conservancy, Bristol, Florida. January and March 2004.

Appendix 1. Eglin AFB Integrated Natural Resource Management Plan section addressing the Florida bog frog.

intended to provide trends of population recovery following the hurricane. As the only unlisted subspecies of Gulf Coast beach mouse, it is thought that documentation of population trends are the only way to prevent listing of the subspecies and to understand the short- and long-term impacts of hurricane impacts on this population. When transects were initially established, no information was available to estimate population variance and calculate needed sample size. A recent review of this monitoring effort evaluated population trends used power analysis to discern the optimum sampling size needed to achieve desired statistical power for future sampling.

POPULATION STATUS AND TREND

The beach mouse tracks showed a statistically significant increase (< 0.0001) from 1996-2000, increasing 4-fold in tracks count frequency since Hurricane Opal. Reductions in sampling effort will likely occur to optimize sampling efficiency with future surveys following a subset of original sampling transects. To optimize efficiency but retain statistical power, future sampling will likely reduce effort to 5 transects, sampled bimonthly.

Bog Frog

GENERAL DESCRIPTION

The bog frog (Rana okaloosae) is one of the most poorly understood species targets at Eglin. Its dorsum is yellowish green to yellowish brown, unspotted; the upper lip is greenish yellow and it has light dorsolateral ridges stop short of groin; very little webbing between toes (on the longest toe, at least 3 phalanges extend beyond the webbing). The Bog Frog is small generally 3.5-4.4 cm snout-vent length (to 4.9 cm); larva is olive brown, with numerous buff spots on the tail and numerous white spots on the venter (Conant and Collins 1991; Moler 1992, 1993).

First discovered in 1982, only general information is available describing its current distribution and habitat needs. It is primarily found in early successional shrub bog communities; in or near shallow, nonstagnant, acid (pH 4.1-5.5) seeps and along shallow, boggy overflows of larger seepage streams that drain extensive sandy uplands, frequently in association with lush beds of sphagnum moss. They are often associated with black titi and Atlantic white cedar. In areas where streamside vegetation is more mature hardwood forest, occurs typically only in disturbed sites, such as utility right-of-way crossings (Moler 1992). Eggs are laid in thin masses at the water surface in pools in adult habitat. Males typically call from shallow water surrounded by sphagnum (Moler 1993). Calling has been heard from mid-April to mid-September; lays eggs probably from April through August; larvae apparently overwinter prior to metamorphosis (Moler 1985, 1992).

Bog Frog

MANAGEMENT DIRECTION

Objectives for management of this species are as follows: 1) Survey known and potential breeding locations of Florida bog frogs to determine current distribution, population size, and turnover, and 2) mark individual Florida bog frogs to begin collecting information on growth, survival, and dispersal.

Initial methods have involved volunteers revisiting all known sites and suitable habitat within the Yellow and East River basins to gather general baseline information. Intensive sampling will begin in the summer of 2001 under the Virginia Tech research program.

We will use information previously collected by Florida Natural Areas Inventory (FNAI) and maps of the base to select study sites. For this species, we will assess population status by measuring the following parameters: number of breeding sites active per year, number of adults per site, and larval density at each site. Where possible, by working with marked individuals, we will also measure growth rate and survival rate, and the frequency, distance, and direction of dispersal events. Species methods will include:

* Survey sites identified by FNAI for calling adults from May-August. Survey additional sites in similar habitat ("shallow, non-stagnant acid (pH 4.1-5.5) seeps and along shallow, boggy overflows . . . [associated with small clear streams that] drain extensive uplands of deep, excessively drained, sandy soils of the Lakeland-Troup series" (Moler 1985)) for calling adults from May-August.
* Use quantified sweep net surveys or leaf litter bags to capture tadpoles year round. Tadpoles can be distinguished from R. clamitans by white spots on the ventral surface of okaloosae (Moler 1993).
* Capture adults using hand-captures, partially submerged funnel traps, and/or dipnets at 2-5 known sites. Measure and mark individuals, probably using PIT tags. Recaptures will allow us to determine growth rates, occupancy of breeding areas in other seasons, and possibly to detect dispersal.

A complete listing of the goals and objectives pertaining to threatened and endangered species can be found in Appendix D.

The bog frog is one of the most poorly understood species targets at Eglin.

Appendix 2. Florida bog frog (*Rana okaloosae*) site data.

Drainage: E, East Bay River; T, Titi Creek; Y, Yellow River. *Conservation Management Unit (CMU):* some sites at lower ends of creeks are assigned to associated floodplain as well as creek. *2004 field check date:* date in parentheses = viewed from distance; U, access denied. *Threats:* B, beaver dam (flooding); C, culvert problem (collapsed, plugged, insufficient); E, substantial erosion; H, hogs; I, impoundment (flooded former habitat); L, power line management (chemical or mechanical clearing); P, borrow pit; R, road (erosion, pollution); S, uplands in sand pine plantation; W, woody encroachment. *Management needs:* B, beaver dam removal; C, culvert clearing, repair, or replacement; F, fire (uplands into riparian zone); H, hog extirpation; I, long-term, very slow and careful drainage, removal of dam, revegetation; L, evaluate and monitor power line management; P, borrow pit closure, repair, revegetation; R, evaluate road crossing for erosion control needs, manage accordingly; U, upland habitat restoration to fire-maintained native forest; X, re-route or close road. Site-specific lists of threats and management needs are not necessarily comprehensive.

FNAI occurrence number	*Site Identifier*	*Drainage*	*Conservation Management Unit (CMU)*	*2004 Field Check Date*	*Bog Frog Last Confirmed **	*Threats (partial)*	*Management Needs (partial)*
1	Malone Creek	Y	Malone Creek	3-3-04	1998	R W	F R
2 (may delete)	unnamed creek, east of Metts Creek, west of Malone Creek	Y	unnamed creek west of Malone Creek	3-3-04	1983	R W	F R
3	Milligan Creek	Y	Milligan Creek	3-3-04	1998	E R W	F R
4	unnamed creek, east of Crane Branch, west of Milligan Creek	Y	unnamed seepage creek, west of Milligan Creek	3-3-04	2003	B E H R W	B F H X
5	Crane Branch	Y	Crane Branch; Yellow River floodplain	3-3-04	1998	B R W	B F R
6	Wolf Creek	Y	Wolf Creek; Yellow River floodplain	3-3-04	1998	R W	F R
7	West Head Dean Creek	E	Dean Creek	1-7-04	1998	B C L W	C F L
8	Hicks Creek	Y	Hicks Creek; Yellow River floodplain	3-3-04	1998	R W	F R

9	Weaver Creek	Y	Weaver Creek; Yellow River floodplain	3-3-04	2000?	C L	C L
10	unnamed creek, east of Malone Creek, west of Middle Creek	Y	unnamed creek, east of Malone Creek	3-3-04	1998	R W	F R
11	Carroll Creek	Y	Carroll Creek	3-3-04	1983	R W	F R
12	Julian Mill Creek[a]	Y	Julian Mill Creek	3-3-04	>1983	E L P R S	F L P R U
13	Garnier Creek[a]	Y	Garnier Creek	3-3-04	1999	L S	L R U
14	Burnt Grocery Creek[a]	Y	Burnt Grocery Creek	3-3-04	>1983	L R W	F L R U
15	Wildcat Branch	T	upper Titi Creek	3-3-04	1985	I R	I R
16	Upper Titi tributary, between Indigo and Cawthon branches	T	upper Titi Creek	3-3-04	2002	R	R
17	Roberts Pond Creek	E	Live Oak Creek and Swamp	1-7-04	1998	H I R	H I R
18	Turtle Creek	E	Turtle Creek	1-7-04	2001	R W	F R
19	Live Oak Creek	E	Live Oak Creek and Swamp	1-7-04	1998	R W	F R
20	Horse Branch	E	Horse Branch	1-7-04	1998	R	R
21	Camp Creek	Y	Camp Creek	3-3-04	1998	E P R W	F P R
22	East Bay River floodplain, 0.9 km E CR 87	E	East Bay River and Swamp	1-9-04	1998	W	F
23	East Bay River floodplain, 1.2 km E CR 87	E	East Bay River and Swamp	1-9-04	1998	W	F
24	seep in East Bay River floodplain, 2.4 km E CR 87	E	East Bay River and Swamp	1-9-04	1998	W	F
25	lower Panther Creek	E	Panther Creek; East Bay River and Swamp	1-9-04	1998	R W	F R
26	Live Oak Creek Swamp east	E	Live Oak Creek and Swamp	(1-7-04)	1998	R	R

27	seep along East Bay Swamp, west of Prairie Creek	E	East Bay River and Swamp	1-9-04	1998	R W	F X
28	tributary of East Bay Swamp, east of Panther Creek	E	unnamed creek east of Panther Creek	1-9-04	1998	R W	F R
29	seep on middle Panther Creek	E	Panther Creek	1-9-04	1998	W	F
30	Panther Creek	E	Panther Creek	1-9-04	1998	W	F
31	upper Panther Creek	E	Panther Creek	U	1998	P R	P R
32	Live Oak Creek Swamp west	E	Live Oak Creek and Swamp	(1-7-04)	1998	L	L
33	Live Oak Creek	E	Live Oak Creek	(1-9-04)	1998	P	P
34	Prairie Creek	E	Prairie Creek	1-9-04	2003	-	-
35	Weaver Creek tributary	Y	Weaver Creek	not examined	1999	-	-
add new sites here in future							

[a] stream located on private lands north of Eglin AFB

Appendix 3. Eglin AFB Integrated Natural Resource Management Plan section addressing erosion control and road management.

Table 4-10

FOREST MANAGEMENT WORK PLAN 2002-2006*	
FOREST SALES	**ACRES PER YR**
Natural Sand Pine Removal	**1600**
Emphasis placed on areas that can support new RCW cluster sites	
Work T&E priority areas that will create immediate RCW habitat	
Plan removal areas to improve RCW habitat and facilitate movement of RCW toward Eglin's boundary	
To be planted with Longleaf pine	
25 year completion at annual removal rate	
Sand Pine Plantation Removal	**500**
Emphasis placed on future RCW habitat improvement/biodiversity management	
To be planted with Longleaf pine	
15 year completion at annual work rate	
Stunted Slash Pine Plantation Removal	**800**
Emphasis placed on future RCW habitat improvement/biodiversity management	
To be planted with longleaf pine	
25 year completion at annual removal rate	
Slash Pine Plantation Thinning/Conversion	**325**
Emphasis placed on future RCW habitat improvement/biodiversity management	
Objective will be conversion to longleaf pine	
Thinning operations will create holes within plantation that will be planted with longleaf pine	
Longleaf Pine thinning inside RCW 350 MEA	**100**
Thinning to improve critical RCW habitat within the MEA	
Longleaf Pine thinning outside RCW 350 MEA	**1000**
Create/emprove RCW habitat between the 350 and 450 MEA boundaries	
Stimulate ground cover	
Begin creation of an unevenaged stand structure	
Improve RCW forage and nesting capabilities	
Improve habitat outside the 450 MEA to begin moving RCW closer to Eglin boundaries	
Sand Pine Seed Tree	**200**
Commercial Forestry operation	
Only accomplished in areas planned for long-term sand pine management	
Commercial Firewood Sales	**100**
Emphasis placed on areas that oak removal will improve RCW habitat	

REFORESTATION	ACRES PER YEAR
Plant Containerized/Bare root longleaf Pine seedlings	**3200**
Average seedlings per acres will vary from 100 to 600 per acre based upon area to be planted	
converted plantations will average 450 for containerized and 600 for bare root seedlings	
containerized longleaf planted by hand	
bare root longleaf seedlings planted by hand or machine based on site conditions	
longleaf seedlings planted by contour of area on a variable spacing of 5 to 20 feet	
planting pattern is design to create natural appearance, not rows	
number of seedlings planted in sand pine removal areas will depend on amount of natural longleaf remaining	
holes and opening will be planted in natural areas to begin creating unevenaged stand structure	
no seedlings planted under existing longleaf pine	
natural regeneration utilized to complete unevenaged stand structure	
Average planting 1,600,000 longleaf pine seedlings	
Contract for longleaf pine cone collection on Eglin will be accomplished when adequate cones are available	
Longleaf pine seed will be purchased (if Eglin seed is not sufficient for needs) within 50 miles of the reservation	
Site Preparation	**2,500**
Both Mechanical and Chemical site preparation will be used. Objective will be to reduce ground cover impacts	
Chemical operations will be favored due to reduced ground-cover impacts	
Mechanical site preparation using roller-drum choppers will be utilized on 500 acres	
clumps and individual trees to remain on site	
single chopping operations will be favored to help protect ground cover	
double chopping opeations will be utilized only where needed to achieve required site preparation	
Chemical site preparation using Velpar herbicide will be utilized on 2000 acres	
clumps and individual trees to remain on site	
2 lbs AI per acre	
buffers created where potential exist for chemical to move off site - special care near roads	
No site preparation will be conducted on 700 acres that will be fuelwooded. The operation provided sufficient preparation	
No mechanical site preparation will be conducted on areas that have never receive site preparation. (Plantations only)	
Native Grasses Restoration	
Develop a seed collection and establishment protocol	
Develop a seed collection partnership outside of Eglin	
Create series of seed collection orchards at 10 sites across the reservation	
6 upland sites; 4 wetland sites	
From a baseline of 400 lbs, increase natural seed harvest by 20 percent each year for 5 years	
Establish native grasses on restoration sites (sand pine removal areas)	
70 percent of seed utilized on restoration areas (sand pine removal)	
30 perecent for orchard development	

FOREST MANAGEMENT WORK PLAN 2002-2006 (Continued)	
TIMBER STAND IMPROVEMENT	**ACRES PER YEAR**
Mechanical TSI (brush ax/chain saw)	750
control sand pine encroachment in artificially planted longleaf pine stands	
Chemical TSI (Velpar)	750
release of natural longleaf pine regeneration from competing oaks	
control of oak competition in artificially planted longleaf pine stands	
control of oaks within RCW cluster sites	
2 lbs AI per acre	

EROSION CONTROL	SITES PER YEAR
Darter Watershed Rehabilitation	25
Program completion by 2004 (New Construction)	
Remove culverts creating impoundments wherever practical	
Establish low-water crossing where practical	
Utilize Natural Resources Conservation Service for contracting/operations/inspection	
Use native grasses	
Non-Darter Watershed Rehabilitation	16
Program completion by 2018 (New Construction) on 206 sites and 65 Claypits	
Sites pritorized by individual watershed	
Utilize Natural Resources Conservation Service for contracting/operations/inspection	
Use native grasses	
Watershed Rehabilitation Maintenance	110
Perform as needed additional earthwork (seeding, mowing, fertilization, stabilization)	
Use native grasses	
Utilize Natural Resources Conservation Service for contracting/operations/inspection	
Maintain site integrity through vehicle exclusion and vigorous vegetation establishment	

ROAD MANAGEMENT
Road maintenance
Maintenance done on an "as required" basis
Road maintenance will be for silvicultural assess only
Best Management Practices will be followed
No major road construction is anticipated

maintained attribution for each road segment and stream crossing containing road conditions, culvert and bridge inventory, and management priorities. FY 2001 saw the completion of the Eglin Range Road Maintenance Handbook. This guide will assist road maintenance crews with effective and affordable best management practices on Eglin's road system. The same team will continue to coordinate on a future road closure program. The NRB will continue to work closely with the 46th TW and 96th CEG to select roads to be permanently closed, seasonally closed, those open to public recreation, those closed to the public, and those that will be used for special purposes, like fire breaks and utility maintenance corridors.

The work plans in Section 4.3.3 present forest activities that will accomplish objectives, which support Principal Goals I, II and III. Acre figures are annual amounts for each activity.

Table 4-13 also shows the labor, cost and income for the forest program,

list of INRMP Goals and Objectives can be found in Appendix D.

I.B.2 Complete operational planning actions and coordinate with Range Configuration Control Committee (RC3) on activities required to achieve desired cover types and sight-lines required by Test Wing Integrated Product Teams, after coordination and approval by TW and when all environmental consultations, permits, and assessments are completed.

II.A.3 Identify and prioritize for treatment, RCW clusters that are adjacent to test ranges, deficient in foraging habitat, and located in areas where future tree removal may be necessary. Encourage population growth in suitable habitats not adjacent to test areas, starting inside the 450 RCW Cluster area and moving outside this area over the next 25 years. Treatments will include all or some of the following forest activities:

- Timber Stand Improvement
  - `Herbicide Application
  - `Mechanical Removal of Sand Pine and Oak
- Sand Pine and Slash Pine Removal (timber sale)
- Site Preparation
- Planting Containerized Longleaf Pine Seedlings

II.B.2 Identify, map and preserve the unique, remnant old-growth longleaf pine communities and associated flora and fauna that meet Special Natural Area criteria by 2003.

II.C.2 By the end of FY02, determine the acreage and locations targeted for forest restoration activities over the next 5-10 years.

II.C.4 By June 2002, determine rates of conversion for Tier II to I and III to II and establish annual conversion objectives.

III.E.1. Reduce process cost by 10% within the next 5 years (2002-2006).

III.E.2. Apply time accounting products, processes and activities to INRMP goals, objectives and strategies in order to accurately capture program costs.

Borrow Pit restoration

III.E.3. Align operational performance indicators with INRMP goals, and objectives.

Erosion Control Program

The NRB has significantly reduced sediment erosion into freshwater streams over the past 7 years. This was accomplished through aggressive delineation of road-management needs and guidelines, restoration of known erosion sites, and research into native grasses.

In 1998-2000 the NRB repaired 120 erosion sites, covering 204 acres. These sites were rehabilitated and sediment reduced by 23,520 tons. Over 550 volunteer hours of work were performed planting native vegetation on erosion sites. These accomplishments resulted in the 2001 Environmental Achievement Award from the International Erosion Control Association (IECA).

The future management direction and priorities for erosion control on Eglin AFB will continue in the same direction as in past years. Our partnership with the Natural Resources Conservation Service will continue. This federal agency has supported our erosion control program in an outstanding manner. Installation and designs for erosion control projects have been exceptional, effective, and very affordable. See Forest Management Work Plan 2002-2006, for the number of planned sites per year for future erosion control projects. Sites will be prioritized on stream sections that are receiving the most sediment to those receiving the least, however, streams with significant Conservation Targets may be prioritized above those that have little biodiversity value.

Road Management

A progressive partnership between the 46th Test Wing, the 96th Civil Engineer Group, and the NRB has resulted in improved road management over the past few years. During 2000, over 42 miles of existing unpaved roadway was reconstructed with Best Management Practices. A GIS database


Native grass seeding on erosion site.

Appendix 4. Copy of Yellow River Ravines project account and map from Florida Forever Five Year Plan, 2003. (Florida Department of Environmental Protection, 2003).
Note: some parcels within the depicted assessment boundary are not included in the project.

Yellow River Ravines

Santa Rosa and Okaloosa County

Group A
Full Fee

Purpose for State Acquisition
This project would protect a high quality example of an imperiled natural community and threatened and endangered plant and animal species. Combined with the 183,000 acres of the Blackwater River State Forest, it will form a continuous corridor of public land from the Eglin Air Force Base through the Conecuh State Forest in Alabama. Acquisition of the project would meet Florida Forever goals of restoring natural habitat and ensuring biodiversity by restoring prescribed fire to areas that would benefit from it, and of increasing natural resource-based recreation by providing areas for camping, picnicking, nature appreciation, hiking and horseback riding. Acquisition of the Yellow River Ravines has also been endorsed by representatives of the U.S. Navy's Pensacola Naval Air Station. Navy officers said at the June 6, 2002 meeting of the Acquisition and Restoration Council that preserving undeveloped land around their satellite airfields enhances military training by preventing encroachment on military reservations.

Manager
Division of Forestry (DOF), Florida Department of Agriculture and Consumer Services (DACS)

General Description
This 16,652-acre project consists of two parcels of land, one on the Yellow River about nine miles east of Milton, and the other being an "infill" parcel in the existing Blackwater River State Forest. The main parcel stretches from the Blackwater River State Forest south to the Yellow River. This project includes a mix of floodplain swamp and floodplain forest, sandhill, mesic flatwoods, wet prairie, dome swamp and seepage stream. About 1,061 acres would protect natural floodplain functions. Much of the floodplain in this project is second-growth forest. The project includes approximately 2,501 acres of functional wetlands and approximately 10,033 acres of land that would provide protection to the surface waters of the state. About 70 percent of the project was originally sandhill, but has been disturbed in the past by being used for silviculture.

FNAI Elements	
Panhandle lily	*G2T3/S3*
Hairy wild indigo	*G2S2*
Sweet pitcherplant	
3 elements known from project	

Public Use
The DOF will promote recreation and environmental education in the natural environment. It is anticipated that interpretive and user services recreation facilities will be developed and the use of low-impact rustic facilities will be stressed.

Acquisition Planning and Status
The Yellow River Ravines project was added to the Florida Forever project list at the June 6, 2002 meeting of the Acquisition and Restoration Council (ARC). This project has 16,652 acres in 41 parcels held by five owners. The essential parcels are those held by International Paper Co.

Coordination
There are no acquisition partners or alternative funding sources identified at this time.

Management Policy Statement
The primary land management goal for the Division of Forestry is to restore, maintain and protect in perpetuity all native ecosystems; to integrate compatible human use; and to insure long-term viability of populations and species considered rare. This ecosystem approach will guide the Division of Forestry's management activities on this project.

Placed on list	**2002**
Project Area (acres)	**16,652**
Acres Acquired	**0**
At a Cost of	**0**
Acres Remaining	**16,652**
With Estimated (tax assessed) Value of	**$12,227,546**

444

Management Prospectus

Qualifications for State Designation

The majority of the acreage of this project consists of what appears to be disturbed sandhill, which has been converted to planted pines of various ages. This acreage has been estimated at 70% of the project, or 9,190 acres. Floodplain swamp represents the second largest land type, and occupies about 2,360 acres. There are lesser acreages of mesic flatwoods, baygalls, seepage streams, wet prairies, and dome swamps. The project's size and diversity makes it desirable for use and management as a state forest. Management by the Division of Forestry as a state forest is contingent upon acquiring fee simple title to the property.

Manager

The Florida Division of Forestry (DOF) of the Department of Agriculture and Consumer Services (DACS) is recommended to be the managing agency.

Conditions affecting intensity of management

Much of the project's plantable areas has been disturbed, and will require restoration efforts. There are approximately 1,200 acres of active timber sales or areas previously harvested that have not been site prepared and planted. Over the next couple of years, these acres will be harvested and will not be replanted by the current landowner. This acreage will require some level of restoration activity. There is at least one linear facility that bisects the parcel, which will be an area of management concern for monitoring unauthorized uses and introduction of invasive exotic species. Additionally, water resource development projects, water supply development projects, stormwater management projects and any linear facilities are considered incompatible with this ecosystem and with the resource values of this project. The activities of Eglin Air Force base may restrict prescribed burning in this area. The level of management intensity and related management costs is expected to be initially high to obtain the necessary information and resources to restore and manage this system as a State Forest. Once this information is obtained and the resources are available, long-term management costs are expected to be moderate to maintain this area as a State Forest, as the Division of Forestry currently manages approximately 189,600 acres in this area.

Timetable for implementing management, and provisions for security and protection of infrastructure

Once the project area is acquired and assigned to the Division of Forestry, public access will be provided for low intensity outdoor recreation activities. The Division of Forestry proposes to manage the site as a part of Blackwater River State Forest, and the Blackwater Forestry Center personnel will carry out management activities and coordinate public access and use. The Division of Forestry will cooperate with and seek the assistance of other state agencies, local government entities and interested parties as appropriate.

Revenue-generating potential

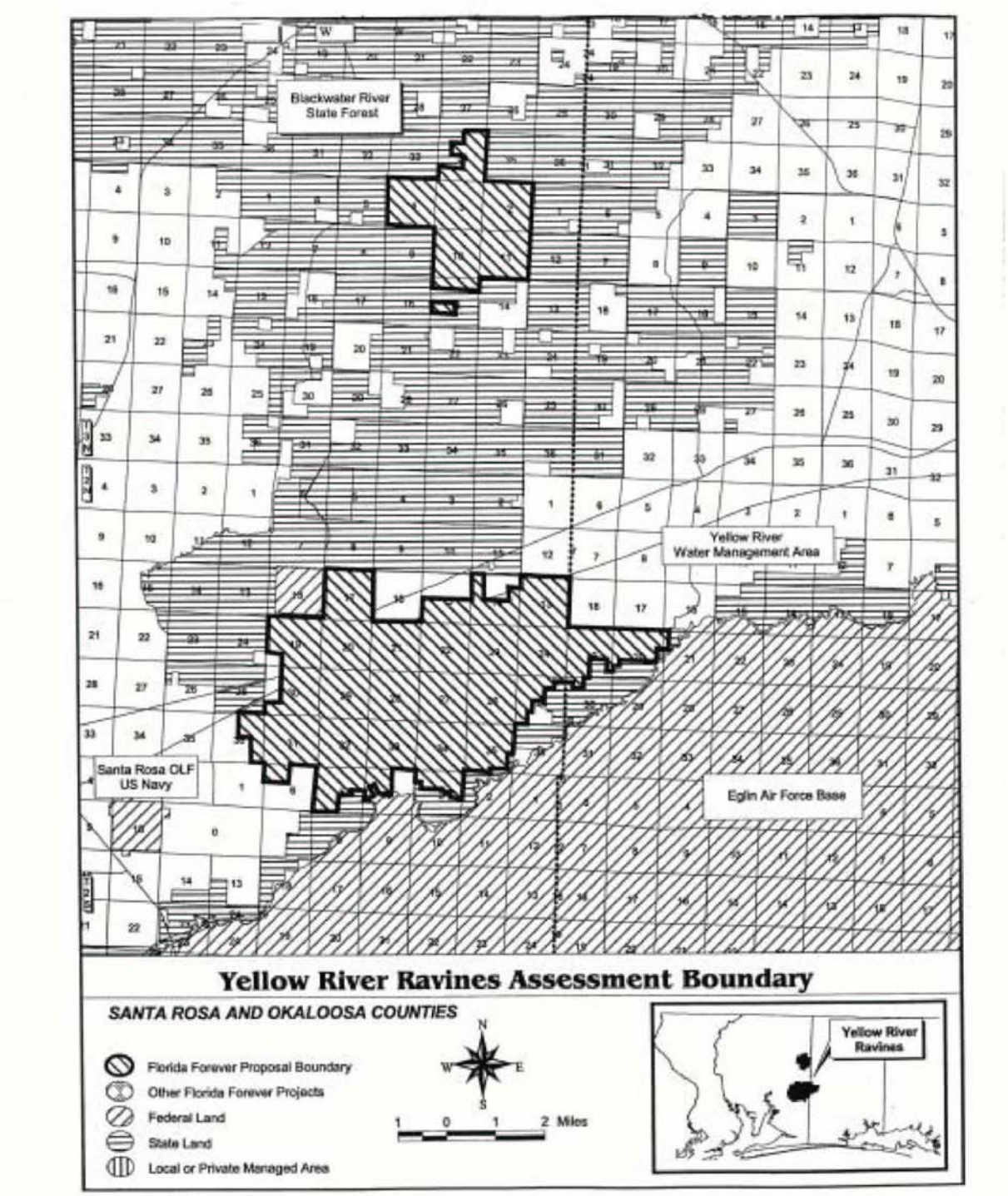
Timber sales will be conducted as needed to improve or maintain desirable ecosystem conditions. These sales will primarily take place in upland pine stands and will provide a variable source of revenue dependent upon a variety of factors. Due to the existing condition of the timber resource on the property, revenue generating potential of this project is expected to be medium.

Management costs and sources of revenue

It is anticipated that management funding will come from the CARL trust fund. Budget needs for interim management are estimated as follows:

SALARY (5 FTE)	**$164,000**
EXPENSE	**$375,000**
OPERATING CAPITAL OUTLAY	
$510,000	
TOTAL	**$1,049,000**

Yellow River Ravines - Group A/Full Fee

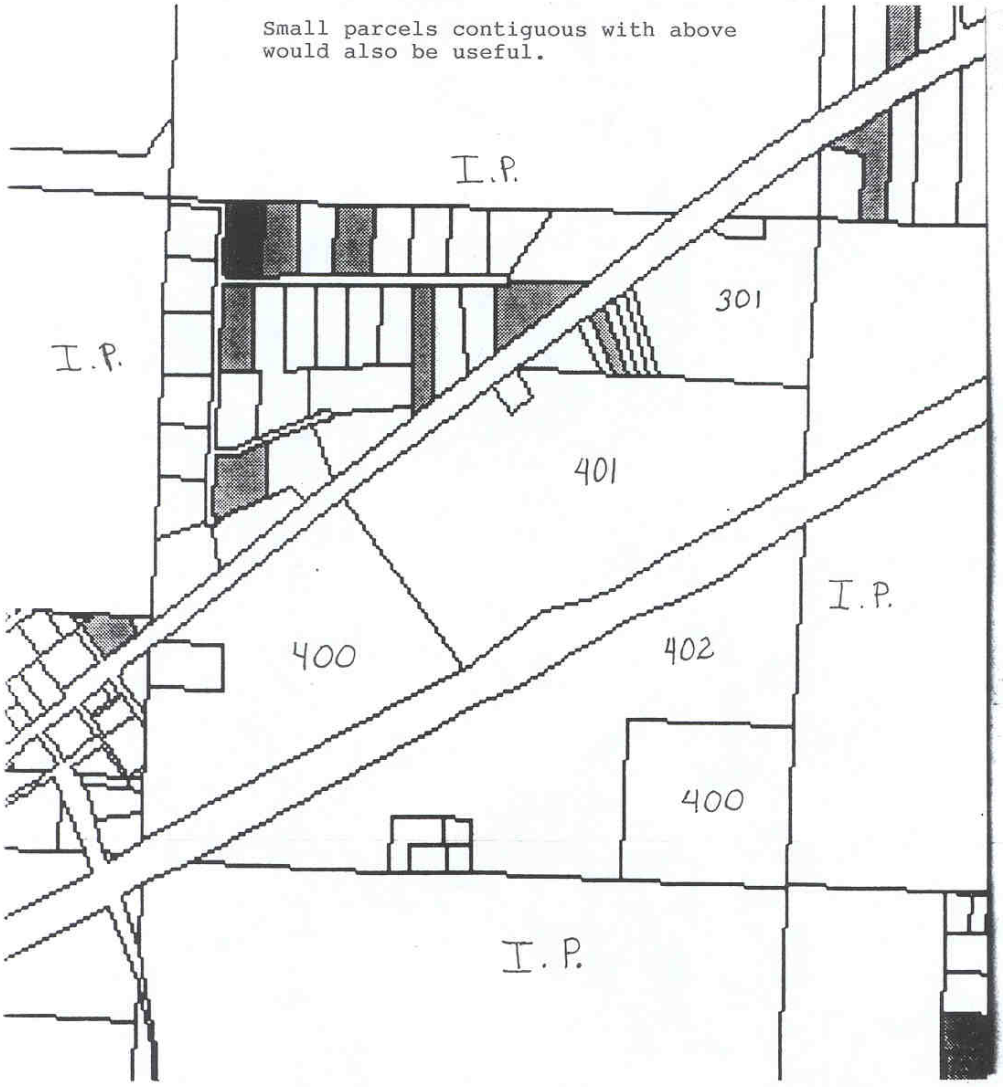


Appendix 5. Map and parcel information depicting lands for consideration for addition to the Florida Forever Yellow River Ravines project. These lands contain most of upper Burnt Grocery Creek. Generated from Santa Rosa County Property Appraiser web site, March 2004.

Section 20 T2N R26W, Santa Rosa County, Florida, that should be considered for addition to Yellow River Ravines Florida Forever Project. Specific parcels to include (and which contain most of upper Burnt Grocery Creek) include:

301 Stokes
400 Stokes - particularly the eastern tract
401 Goff
402 Hobbie

Small parcels contiguous with above would also be useful.



Gregory S. Brown, CFA
Santa Rosa County
Property Appraiser
6495 Caroline Street
Milton, Florida 32570
(850) 983-1880 Voice
(850) 623-1284 Fax
info@srcpa.org

Print Labels

PARCEL NUMBER	OWNER NAME	ADDRESS	HOMESTEAD	
20-2N-26-0000-00100-0000	BYROM WILLIAM H & FRANCES R		N	
20-2N-26-0000-00100-0000 M	HANNA HAYWOOD & JULIA B		N	Acres
20-2N-26-0000-00100-0010 M	ESTES JAMES T & SYNOVUS TRUST		N	
20-2N-26-0000-00100-0020 M	MARNUL JOYCELYN		N	
20-2N-26-0000-00200-0000 M	WILLIAMS H L		N	
20-2N-26-0000-00301-0000	STOKES JOSEPH G		N	35.81 ac.
20-2N-26-0000-00303-0000	DUGAN JUDITH A	10849 HWY 90	N	
20-2N-26-0000-00304-0000	VYVX INC D/B/A/	12539 HWY 90	N	
20-2N-26-0000-00305-0000	SANBORN MICHAEL WILLIAM JR		N	
20-2N-26-0000-00306-0000	THOMPSON ROGER		N	
20-2N-26-0000-00307-0000	THOMAS BOBBY G & KELLIE	10875 HWY 90 E	N	
20-2N-26-0000-00308-0000	ARNE GLEN E & TRACY D	10871 HWY 90 E	N	
20-2N-26-0000-00309-0000	SANBORN MICHAEL WILLIAM JR	10865 HWY 90	N	
20-2N-26-0000-00400-0000	STOKES JOSEPH G L		N	116.41 ac.
20-2N-26-0000-00401-0000	GOFF BOBBY C		N	114.8 ac.
20-2N-26-0000-00402-0000	HOBBIE ERNESTINE S TRUSTEE		N	116.6 ac.
20-2N-26-0000-00500-0000	REEVES WAYNE EUGENE &	10815 HWY 90	Y	
20-2N-26-0000-00700-0000	MILLER DONALD A & TONYA R	BLUE BARNES RD	N	
20-2N-26-0000-00801-0000	HARIELSON LUCILLE & JAMES T		N	
20-2N-26-0000-00900-0000	BARNES L J JR & BARBARA	10780 BLUE BARNES RD	Y	
20-2N-26-0000-00901-0000	BARNES STEPHEN LEWIS	10794 BLUE BARNES RD	Y	
20-2N-26-0385-00000-0000	BLACK WATER RIVER		N	
20-2N-26-0385-00000-0010	BENTON ALICE &	6540 WAYLON DR	Y	
20-2N-26-0385-00000-0020	BELCAS JAMES P & JUANITA F		N	
20-2N-26-0385-00000-0030	BROSSETT MARVIN L & RITA A	10686 HATCHER ST	Y	
20-2N-26-0385-00000-0040	DEUTSCHE BANK	10712 HATCHER ST	N	
20-2N-26-0385-00000-0050	ENFINGER DOUGLAS W	10742 HATCHER ST	Y	
20-2N-26-0385-00000-0060	HALL RICHARD SHANE		N	
20-2N-26-0385-00000-0070	OLWICK HAROLD J & DIANE M	10780 HATCHER ST	N	
20-2N-26-0385-00000-0080	CORRIGAN CHRISTOPHER S	10806 HATCHER ST	Y	
20-2N-26-0385-00000-0090	WILSON J C & SUE & GARY		N	
20-2N-26-0385-00000-0100	CORY GLEN & BARBARA	10807 HATCHER ST	Y	
20-2N-26-0385-00000-0110	KELLEY JOSEPH E	10793 HATCHER ST	Y	
20-2N-26-0385-00000-0120	BAILES WILLIAM J & LINDA D		N	
20-2N-26-0385-00000-0130	FANNIN DAVID M & BARRON OPAL J	10755 HATCHER ST	N	
20-2N-26-0385-00000-0140	CREGGER ROBERT A & SHERRY	10743 HATCHER ST	N	
20-2N-26-0385-00000-0150	HOURIHAN KIM KAROL	10723 HATCHER ST	Y	
20-2N-26-0385-00000-0160	STOKES CURTIS E & NANCY L		N	
20-2N-26-0385-00000-0170	STOKES NANCY L & CURTIS E	10683 HATCHER ST	Y	
20-2N-26-0385-00000-0190	CARPENTER MAGGIE L	6524 WAYLON DR	Y	
20-2N-26-0385-00000-0200	HARRIS BENJAMIN J	6472 WAYLON DR	Y	
20-2N-26-0385-00000-0210	NEWBY JOHN J JR & CRYSTAL LEE	10676 SUN UP CT	Y	
20-2N-26-0385-00000-0220	JONES WILLIAM C JR & LISA A	10706 SUN UP CT	Y	
20-2N-26-0385-00000-0230	JONES STEVE C & TERESA A	10707 SUN UP CT	Y	

Appendix 6. Draft document reviewers and affiliations.

Review does not necessarily imply concurrence with all statements in document.

J.J. Bachant Brown
Gulf Coastal Plain Ecosystem Partnership
4025 Highway 178
Jay, FL 32565

David C. Bishop
Department of Fisheries and Wildlife Sciences
Virginia Polytechnic Institute and State University
Blacksburg, VA 24061

Richard Franz
Florida Museum of Natural History
University of Florida
Gainesville, FL 32611

Daniel Friese
U.S. Air Force
HQ AFCEE/TDI
3300 Sidney Brooks
Brooks City-Base, TX 78235-5112

Richard Gooch
Southeast Regional Office
U.S. Fish and Wildlife Service
1875 Century Blvd., Suite 200
Atlanta, GA 30345

Bruce Hagedorn
Bob Miller
Dennis Teague
107 Hwy 85 North
Natural Resources Branch
Eglin Air Force Base
Niceville, FL 32578

John Jensen
Georgia Department of Natural Resources
Nongame Wildlife Program
116 Rum Creek Drive
Forsythe, GA 31029

Patricia Kelly
U.S. Fish and Wildlife Service
Panama City Ecological Services Field Office
1601 Balboa Avenue
Panama City, FL 32405

Paul E. Moler
Florida Fish and Wildlife Conservation Commission
4005 S. Main St.
Gainesville, FL 32601

David J. Printiss
The Nature Conservancy
Northwest Florida Program
P.O. Box 393
Bristol, FL 32321