

COASTAL GOLDENROD

MANAGEMENT GUIDELINES FOR SPECIES AT RISK ON DEPARTMENT OF DEFENSE INSTALLATIONS



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

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COASTAL GOLDENROD

MANAGEMENT GUIDELINES FOR SPECIES AT RISK ON DEPARTMENT OF DEFENSE INSTALLATIONS

CAMP LEJEUNE MARINE CORPS BASE
NORTH CAROLINA

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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

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

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

NCNHP

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

NCPCP

- o Population Monitoring: 16 hours each year for 2 years (developing and implementing initial monitoring) = 16 hours
- o Data entry and analysis: 2 hours each year for 5 years (biennially) = 10 hours
- o 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.

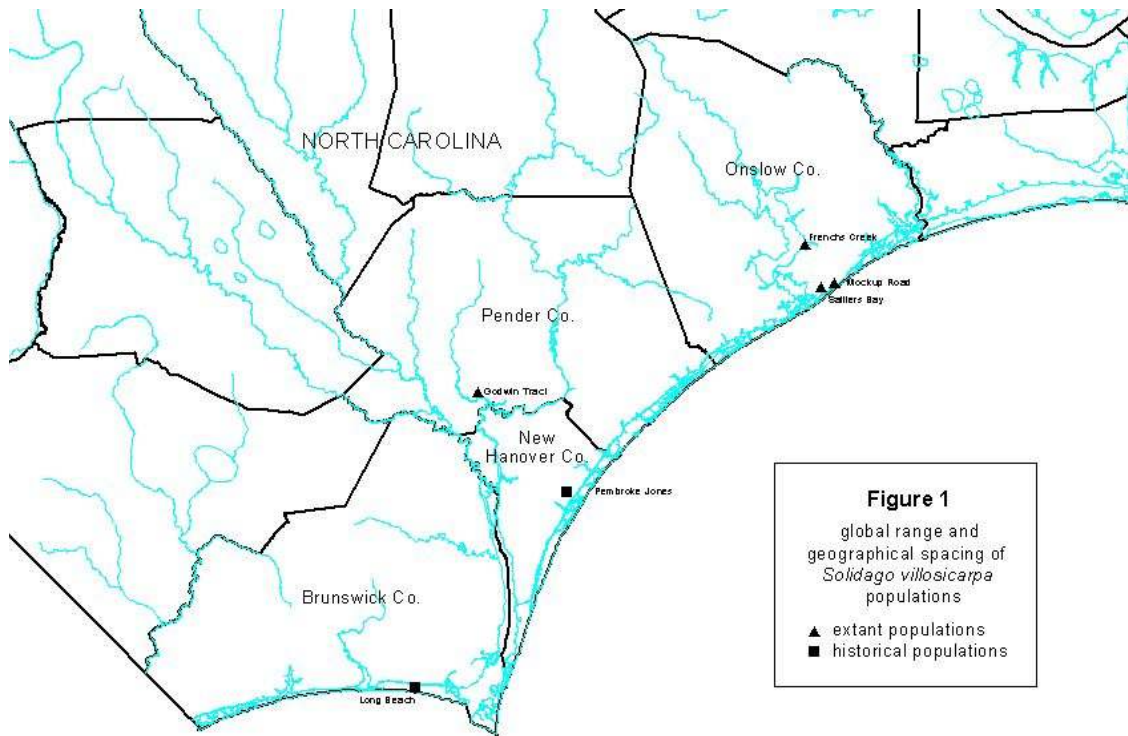
What is the timetable for implementing the conservation actions? List dates for when specific conservation objectives will be met.

- 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)

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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 composition 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.

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

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

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

