

Showy Indian Clover
(*Trifolium amoenum*)

5-Year Review:
Summary and Evaluation



Photo credit: Valary Bloom

U.S. Fish and Wildlife Service
Sacramento Fish and Wildlife Office
Sacramento, California

December 2007

5-YEAR REVIEW
Showy Indian Clover (*Trifolium amoenum*)

TABLE OF CONTENTS

I. General Information.....	1
I.A. Reviewers	1
I.B. Methodology used to complete the review.....	1
I.C. Background.....	1
II. Review Analysis.....	2
II.A. Application of the 1996 Distinct Population Segment (DPS) policy.....	2
II.B. Recovery Criteria.....	2
II.C. Updated Information and Current Species Status.....	2
II.D. Synthesis.....	9
III. Results.....	9
III.A. Recommended Classification.....	9
III.B. New Recovery Priority Number.....	9
IV. Recommendations For Future Actions.....	9
V. References.....	10

5-YEAR REVIEW
Showy Indian Clover/*Trifolium amoenum*

I. GENERAL INFORMATION

I.A. Contacts

Lead Regional or Headquarters Office --Contact name and phone number:

Diane Elam, Recovery Coordinator, Region 8 (California and Nevada), (916) 414-6464.

Lead Field Office -- Contact name and phone number:

Kirsten Tarp, Recovery Branch Chief, Sacramento Fish and Wildlife Office (SFWO), (916) 414-6600.

I.B. Methodology used to complete the review

This review was conducted by a biologist within the Sacramento Fish and Wildlife Office (SFWO), using information from species survey and monitoring reports and peer-reviewed journal articles. Survey information, peer reviewed publications and personal communications with experts on the species from academia, were the primary sources of information used to update the species status and threats section of this review.

I.C. Background

I.C.1. FR Notice citation announcing initiation of this review:

On March 22, 2006, we, the U.S. Fish and Wildlife Service, announced initiation of the 5-year review for *Trifolium amoenum* and asked for information from the public regarding the species status (71FR14538). We received no response to this request for information.

I.C.2. Listing history

Original Listing

FR notice: 62 FR 55791

Date listed: October 22, 1997

Entity listed: Species: *Trifolium amoenum*

Classification: Endangered

I.C.3. Review History:

No status reviews or other relevant reviews have been conducted since the listing in 1997.

I.C.4. Species' Recovery Priority Number at start of review:

2 (full species, high degree of threat, high recovery potential).

I.C.5. Recovery Plan or Outline

There is not yet a recovery plan for this species.

II. REVIEW ANALYSIS

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

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

II.B. Recovery Criteria

II.B.1. Does the species have a final, approved recovery plan containing objective, measurable criteria?

Yes

No. A recovery plan has not been completed.

II.C. Updated Information and Current Species Status

Trifolium amoenum is an annual plant in the Fabaceae (pea) family which was first described by Edward L. Greene from specimens collected in 1890 near Vanden, Solano County, California (Greene 1891). The range of the species was originally from Mendocino County south to Sonoma, Marin, Alameda, and Santa Clara Counties, and east to Napa and Solano Counties. Currently, it is reduced to one native population in Marin County and one experimental population in Sonoma County (Connors 2007). The species has been found in a variety of habitat including low, wet swales, grasslands, and grassy hillsides up to 310 meters (1,020 feet) in elevation.

The species was considered extinct until 1993 when a single plant was discovered on privately-owned property (Occidental) in Sonoma County. That site has since been developed and the species is no longer present. Another native population was discovered in 1996 in Dillon Beach, Marin County, on privately-owned property. Results of a 2006 survey of that population indicate a dramatic decline in numbers to the lowest level in the entire 10-year monitoring period (Connors 2007).

II.C.1. Biology and Habitat –

Spatial distribution, trends in spatial distribution, or historic range:

In general, spatial distribution of *Trifolium amoenum* has been severely reduced. Whereas it was once known from 20 historical occurrences in seven counties, by the mid 1900's, it had become rare and the species was listed as “presumed extinct” by the California Native Plant Society in 1985. *Trifolium amoenum* was considered extinct until 1993 when it was rediscovered. A second site was discovered in 1996. The site discovered in 1993 (near Occidental) has now been developed, and the plant is considered extirpated there. The only known natural site is on the bluffs at Dillon Beach in Marin County, discovered in 1996 (U.S. Fish and Wildlife Service 1997). In addition to the native site, a small experimental population has been started at the Bodega Marine Laboratory in Sonoma County (Connors 2006, see also discussion below). Both the native and the experimental populations are of the prostrate coastal bluff form (growth forms discussed further below in the Genetics section). In addition, Diana Immel sowed seed of the upright inland form at two sites in the fall of 2006 (described below), but it is too early to determine the success of this effort. There are no known native populations of the upright inland form.

Abundance, population trends

Since the time of listing in 1997, Dr. Peter Connors, researcher with University of California, Davis, has conducted annual monitoring of this Marin County population at Dillon Beach. He has found high interannual variability in number of plants and in seed production, with a general trend of a population increase through 2005, but a sharp decline in 2006 (Connors 2006). It is too soon to know whether this sudden decline will continue, or whether the population will recover quickly or slowly. During monitoring of the Dillon Beach population, plants were identified about 500 meters (1640 feet) north of the main population in 2005. Five plants at this northern site survived to set seed in 2005; however, no plants were found at the northern site during the 2006 survey (Connors 2006).

In 1997, Dr. Connors started a very small experimental population (approximately 20 seedlings) at the Bodega Marine Laboratory from the seed collected from the Dillon Beach plants (Connors 2007). This population is not routinely monitored and it is not known whether these plants will be self-sustaining. In addition, Diana Immel, a University of California, Davis, PhD. candidate, sowed seed at two sites in Sonoma County (California Department of Fish and Game's Wright Unit of the Santa Rosa Plain Ecological Preserve, and Ocean Song Farm and Wilderness Center) and at Point Reyes National Seashore in Marin County in fall 2006. Ms. Immel has documented germination at most of these sites. However, at the time of this writing, it is too soon to know whether those seedlings will survive to set seed of their own. For this project, Ms. Immel used seed derived from the now-extirpated single-founder population identified near Occidental in 1993. She has used the same seed source to maintain approximately

one dozen plants at her residence for seed multiplication and research (Immel 2006, *in litt.*).

Trifolium amoenum populations at the Dillon Beach bluffs and Bodega Marine Laboratory sites plummeted in 2006 from relatively high numbers in 2005, with seedling number on the Dillon Beach transects declining by 94% and seed productivity declining by 98%. The number of seeds produced in 2006 on the transects was the lowest of the entire 10-year monitoring period (Connors 2006). Quantitative monitoring of the Bodega Marine Laboratory population was not conducted. However, a corresponding decline was observed in those as well (Connors 2006).

Prior to listing, seed multiplication of the Occidental plant by Dr. Connors had increased the number of available seeds to over 50,000 (Connors 2007). These are being stored at three California facilities: Rancho Santa Ana Botanic Garden in Claremont; the University of California at Berkeley Botanical Garden in Berkeley, and the University of California Bodega Marine Laboratory Herbarium in Bodega Bay. Seeds from the extant population in Dillon Beach have also been collected and multiplied to over 20,000 and are being stored at the University of California Bodega Marine Laboratory Herbarium (Connors 2007). Seeds from both populations also have been submitted to the National Seed Storage Laboratory in Fort Collins, Colorado. These seed collections represent both the prostrate form (from Dillon Beach bluffs) and the upright inland form (from near Occidental).

Genetics, genetic variation, or trends in genetic variation:

Since the time of listing, it has been determined that *Trifolium amoenum* uses a mating system of cross-, as well as self-pollination (*i.e.*, a mixed mating system). Through studies of both the Occidental seed source and the existing Dillon Beach population, a higher level of heterozygosity was indicated than would be expected in a predominantly self-pollinating species (Knapp and Connors 1999). In the same study, the authors suggested that the existence of genetic variation in the Occidental population provides empirical evidence that the seed from which the Occidental plant grew may have germinated from a long-dormant seed bank produced many years earlier when the population was much larger.

Since the time of listing, genetic analysis of *Trifolium amoenum* has been carried out, resulting in two relevant determinations. First, *T. amoenum* has already lost genetic variability. The seeds that Dr. Connors multiplied were derived from the single-founder population which he discovered in 1993 near Occidental; this population passed through an extreme population bottleneck that appears to have restricted its genetic variation. Studies conducted by Knapp and Connors (1999) suggest that, although the single individual found at the Occidental site had a relatively high degree of genetic variability, it is less genetically variable than the original *T. amoenum* population from which it was derived. This loss of genetic variability underscores the need for outcrossing.

Secondly, seeds from the population discovered by Dr. Connors on Marin County coastal bluffs in 1996 produce plants distinctly different in growth form from all the offspring of the Occidental plant and from all the herbarium specimens he has examined. The Dillon Beach bluffs plants grow almost prostrate and have more spherical heads than the very upright inland form from near Occidental. When plants of both growth forms were grown in a common garden at an inland location near Occidental, the differences in plant morphology were maintained (Knapp and Connors 1999). Plants with the prostrate growth form appear to be genetically distinct, most likely a local adaptation to conditions on the windy coastal bluffs. The potential for genetic distinctness necessitates conservation of both growth forms.

Habitat or ecosystem conditions:

Areas of habitat similar to the sites of the Dillon Beach bluff population and the experimental population at Bodega Marine Laboratory exist in other parts of (at least) Sonoma and Marin Counties, primarily on private lands, but with some potential sites on public lands. Much of the habitat which was suitable at the time of listing has been altered and is now unsuitable due to urbanization, agricultural operations, and changes in the biological community and hydrological conditions. Areas such as Point Reyes National Seashore, with relatively intact native communities, provide the best opportunities for reintroduction (Connors 2006 *in litt.*). Most areas with appropriate habitat now set aside for conservation (*i.e.*, Tolay Lake, Wright Unit of Laguna de Santa Rosa Preservation Bank, etc.) are highly disturbed and require management to address problems such as overabundance of non-native plants and herbivore populations before reintroduction efforts could be considered (Immel 2006, *in litt.*). Resources should be put toward resolving these problems soon so that otherwise appropriate habitat in conservation ownership may be considered for reintroduction.

II.C.2. Five-Factor Analysis

III.C.2.a. Present or threatened destruction, modification or curtailment of its habitat or range:

The listing rule (U.S. Fish and Wildlife Service 1997) noted that loss of habitat at the historically known 20 occurrences resulted primarily from urbanization and land conversion to agriculture and that loss of the site near Occidental was due to development. Widespread urbanization continues throughout the historic range of *Trifolium amoenum* (Immel 2006 *in litt.*, U.S. Fish and Wildlife Service 1997). Urbanization and agriculture may be preventing establishment of the plant within historic habitat where it is currently not known to occur. The single known native population is located on private property in a developed area. Construction of a house within 100 feet of the population, which was underway at the time of listing, has now been completed (Connors 2007). Future plans for development on this private property are not known.

The proximity of this population to a coastal bluff also threatens the population with extirpation through erosion. A small trail providing local homeowners with access along the bluffs runs directly through the population. Although current use of the trail does not appear to threaten the population, any increase in use or expansion of the trail could adversely affect the population (Connors 2006).

The Bodega Marine Laboratory experimental population is small in area and in number of plants, and is located near heavily used buildings. This population faces the threat of trampling (Connors 2006). However, it is signed to prohibit unauthorized entry and reduce unnecessary foot traffic.

II.C.2.b. Overutilization for commercial, recreational, scientific, or educational purposes:

No new information exists in regard to the threat of overutilization for commercial, recreational, scientific, or educational purposes. As stated in the listing, “Any occurrences of *Trifolium amoenum* that may be discovered in the future also may attract collectors of plants or seed because the species was previously thought to be extinct” (U.S. Fish and Wildlife Service 1997). However, we have no evidence to suggest that this has occurred.

II.C.2.c. Disease or predation:

The listing rule (U.S. Fish and Wildlife Service 1997) suggested that some historic locations of *Trifolium amoenum* may have been eliminated due to grazing. However, the one known native population on the Dillon Beach bluffs was not threatened by grazing at the time of listing.

Since the time of listing, a high level of gopher grazing has been observed to impact the *Trifolium amoenum* population at Dillon Beach. In fact, gopher activity accounted for most of the mortality observed during Connor’s 2007 survey of the population (Connors 2007). Other likely native herbivores include deer, rabbits, voles, snails, slugs, and insects. Although herbivory can have deleterious effects on plants, predation by gophers may also benefit *Trifolium amoenum* by disturbing areas and reducing competition from non-native plants. The Bodega Marine Laboratory population faces herbivory by deer, voles, and introduced slugs. Although some grazing or herbivory occurs, we do not consider it to be a major threat to the species at this time.

II.C.2.d. Inadequacy of existing regulatory mechanisms:

The Federal Endangered species Act: The Endangered Species Act of 1973, as amended (Act), is the primary Federal law that provides protection for *Trifolium amoenum*. Section 7(a)(2) requires Federal agencies to consult with the Service to ensure any project they fund, authorize, or carry out does not jeopardize a listed species. Section 9 of the Act and Federal regulations pursuant to section 4(d) of

the Act prohibit the “take” of federally-endangered wildlife. However, plants are not protected against take. Instead, plants are protected from harm in two particular circumstances. Section 9 prohibits (1) the removal and reduction to possession (i.e. collection) of endangered plants from lands under Federal jurisdiction, and (2) the removal, cutting digging, damage, or destruction of endangered plants on any other area in knowing violation of a state law or regulation. Section 9 also makes illegal the international and interstate transport, import export and sale or offer for sale of endangered plants and animals. The protection of Section 9 afforded to endangered species is extended to threatened wildlife and plants by regulation. The Act affords protection to federally-listed plants if they co-occur with federally-listed wildlife species.

Under the terms of section 7(b)(4) and section 7(o)(2) of the Act, taking that is incidental to and not intended as part of the agency action is not considered to be prohibited taking under the Act provided that such taking is in compliance with the terms and conditions of an incidental take statement. Sections 7(b)(4) and 7(o)(2) of the Act generally do not apply to listed plant species. However, limited protection of listed plants from take is provided to the extent that the Act and the implementing regulations prohibit the removal and reduction to possession of federally listed threatened or endangered plants or the malicious damage of endangered plants on areas under federal jurisdiction, or the destruction of endangered plants on non-federal areas when in violation of state law or regulation or in the course of any violation of a state criminal trespass law.

California State Laws: The State’s authority to conserve plants is comprised of four pieces of legislation: The California Endangered Species Act (CESA), the Native Plant Protection Act (NPPA), the California Environmental Quality Act (CEQA), and the Natural Community Conservation Planning Act (NCCPA). *Trifolium amoenum* is not listed under CESA.

The California Environmental Quality Act (CEQA) (chapter 2, section 21050 *et seq.* of the California Public Resources Code) requires government agencies to consider and disclose environmental impacts of projects to not only federally listed species, but also to those considered “rare” by other agencies or professional associations. *Trifolium amoenum*, although not state listed, is considered a List 1B plant by the California Native Plant Society. Any impacts to *T. amoenum* would be subject to evaluation through CEQA. The CEQA also requires the avoidance or mitigation of those impacts, where possible. Under CEQA, public agencies must prepare environmental documents to disclose environmental impacts of a project and to identify conservation measures and project alternatives. Through this process, the public can review proposed project plans and influence the process through public comment. However, CEQA does not guarantee that such conservation measures will be implemented.

Currently there are no completed regional or county-wide Habitat Conservation Plans per the Federal Endangered Species Act (HCPs) or Natural Community

Conservation Plans (NCCPs) per the Natural Community Conservation Planning Act at either of the two known occurrences.

II.C.2.e. Other natural or manmade factors affecting its continued existence:

The listing rule (U.S. Fish and Wildlife Service 1997) indicated that *Trifolium amoenum* may be adversely affected by non-native invasive species as well as by the effects of small population size and low number of extant populations. These factors continue to threaten the species as described below.

Non-native invasive species. The long-term threats to the Dillon Beach population include invasion by the non-native *Carpobrotus edulis* (iceplant or sea fig). This plant, which competes for habitat with *Trifolium amoenum*, was planted for fire and erosion control in the adjacent yard and reached the *T. amoenum* population for the first time in 1999. Dr. Connors has recently reached agreement with that landowner on an iceplant control program involving both hand-pulling and herbicide (Roundup) application (Connors 2006). Other invasive competitors already present at the site, including *Lolium multiflorum* (Italian ryegrass) and *Plantago lanceolata* (English plantain), may gain in population size or density at the expense of *T. amoenum* (Connors 2006, *in litt.*). In addition, the non-native grass *Holcus lanatus* (velvet grass) is not currently at the site but has invaded many coastal bluff plant communities in the area. It could be a strong invader of the *T. amoenum* population if it became established at the Dillon Beach site (Connors 2006).

The experimental population of *Trifolium amoenum* at the Bodega Marine Laboratory also faces competition from non-native invasive plant species. Staff of the Bodega Marine Laboratory reduce competition with *Medicago polymorpha* (California burclover), *Plantago coronopus*, and *Plantago lanceolata*, among other species, by weeding (Connors 2006).

Small population size and few populations. As discussed in the listing rule (U.S. Fish and Wildlife Service 1997), the conservation biology literature commonly notes the vulnerability of taxa known from one or very few locations and/or from small populations (*e.g.*, Shaffer 1981, 1987; Primack 1998; Groom et al. 2006). That *Trifolium amoenum* occurs in small numbers and at few locations has not changed since the time of listing. Therefore, threats associated with these factors remain. The combination of a single native population, small range, and restricted habitat makes this species highly susceptible to extinction or extirpation due to random events, such as flood, drought, disease, or other occurrences.

II.D. Synthesis -

Our analysis indicates that the threats to *Trifolium amoenum* have not substantially changed since the time of listing. The primary threats continue to be potential destruction and modification of habitat and the effects associated with small population size and/or few locations (such as susceptibility to catastrophic random events). The only known native population has not been protected, and neither it nor the experimental population at Bodega Marine Laboratory are managed strictly for the conservation of *T. amoenum*. A secondary threat to the species at the only known native site is erosion.

Although some additional progress has been made in reintroducing seed to suitable habitat at two other sites within the historic range, it is too soon to know if these efforts will result in self-sustaining populations, which could reduce the threat of extinction due to random catastrophic events. It will be a positive step toward recovery if the *Trifolium amoenum* seeds sown at sites in Sonoma and Marin Counties in fall 2006 exhibit high germination and seed production rates and ultimately become self-sustaining. In addition, the ex situ seed banking should provide an additional safety net should the single native or experimental populations decline further.

After reviewing the best available scientific data, the Service has concluded that *Trifolium amoenum* continues to meet the definition of endangered.

III. RESULTS

III.A. Recommended Classification:

- Downlist to Threatened
- Uplist to Endangered
- Delist (*Indicate reasons for delisting per 50 CFR 424.11*):
 - Extinction
 - Recovery
 - Original data for classification in error
- No change is needed

III.B. New Recovery Priority Number 2 (No change)

It is recommended that the recovery priority number remain 2 because the species continues to have a high degree of threat and a high potential for recovery.

IV. RECOMMENDATIONS FOR FUTURE ACTIONS -

The following recommendations for future actions are based on discussions of the status of the species and the species' needs with recognized *Trifolium amoenum* experts:

- 1) Complete and implement a recovery plan for *Trifolium amoenum* which outlines specific recovery criteria and recovery tasks.
- 2) Continue to monitor known populations of *Trifolium amoenum* so as to discern population sizes and the differences between natural and unnatural population fluctuations.
- 3) Conduct range-wide surveys to identify additional populations for protection and out-crossing purposes.
- 4) Expand the genetic base of the Occidental population, currently used for reintroduction experiments, to prevent further loss of evolutionary potential and the possibility of deleterious effects associated with inbreeding. Any additional plants found as a result of (3) above should be used to expand the genetic variability. If no additional individuals are identified, the Dillon Beach population should be used. Much care must be used during this process, however, as phenotypic difference between the two populations are likely adaptive. Through “controlled introgression”, a small proportion of the non-local Dillon Beach source seed could be mixed into the Occidental population over time, such that local adaptive variation is maintained while promoting adequate levels of within population genetic variation (Knapp and Connors 1999).
- 5) Reintroduce both growth forms into suitable habitat. The two forms of *Trifolium amoenum* should be treated separately in any reintroduction efforts, however, because these forms have morphological differences which may be adaptive. The establishment of a self-sustaining population in a preserved area would greatly increase the chance for recovery of this species. Suitable habitats might be found at the Bodega Marine Laboratory or on State or Federal lands in the area.
- 6) Conduct research into (a) the role of herbivory, (b) whether the presence of gophers is beneficial or detrimental, (c) reasons for interannual variability in population numbers and seed productivity, (d) the tolerance of *Trifolium amoenum* to different soil types, and (e) the effect of disturbance regimes on *T. amoenum*, among other topics.

V. REFERENCES -

- Connors, P.G. 2006. Annual report to the U.S. Fish and Wildlife Service Endangered Species Recovery Program: conservation and monitoring of the coastal form of *Trifolium amoenum* E. Greene (Fabaceae), showy Indian clover. University of California, Davis.
- Connors, P.G. 2007. Annual report to the U.S. Fish and Wildlife Service Endangered Species Recovery Program: conservation and monitoring of the coastal form of *Trifolium amoenum* E. Greene (Fabaceae), showy Indian clover. University of California, Davis.
- Greene, E. L. 1891. *T. amoenum*. Flora Franciscana. p. 27.

- Groom, M.J., G.K. Meffe and C.R. Carroll. 2006. Principles of Conservation Biology, third edition. Sinauer Associates, Sunderland, Massachusetts.
- Knapp, E.E. and P.G. Connors. 1999. Genetic consequences of a single-founder population bottleneck in *Trifolium amoenum* (Fabaceae). Amer. J. Botany 86:124-130.
- Primack, R.B. 1998. Essentials of Conservation Biology. Sinauer Associates, Sunderland, Massachusetts.
- Shaffer, M.L. 1981. Minimum conservation sizes for species conservation. Bioscience 31: 131-134.
- Shaffer, M.L. 1987. Minimum viable populations: coping with uncertainty. Pages 69-86 in M.E. Soulé (editor). Viable Populations for Conservation. Cambridge University Press, New York, New York.
- U.S. Fish and Wildlife Service (Service). 1997. Endangered and threatened wildlife and plants; determination of endangered status for nine plants from the grasslands and mesic areas of the central coast of California. Federal Register 62: 55791-55808.

In Litt.

- Connors, Peter. 2006. Principal Museum Scientist, University of California, Davis. E-mail to Valary Bloom, U.S. Fish and Wildlife Service, Sacramento Fish and Wildlife Office, Sacramento, California, dated December 26, 2006. Subject: Review of *Trifolium amoenum* 5-year review.
- Immel, Diana. 2006. PhD. candidate, University of California, Davis. E-mail to Valary Bloom, U.S. Fish and Wildlife Service, Sacramento Fish and Wildlife Office, Sacramento, California, dated December 21, 2006. Subject: Review of *Trifolium amoenum* 5-year review.

U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW of Showy Indian Clover (*Trifolium amoenum*)

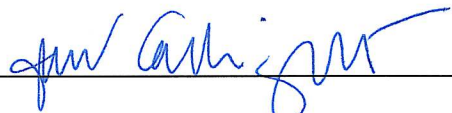
Current Classification Endangered
Recommendation resulting from the 5-Year Review

- Downlist to Threatened
- Uplist to Endangered
- Delist
- No change is needed

Review Conducted By Sacramento Fish and Wildlife Office staff

FIELD OFFICE APPROVAL:

Lead Field Supervisor, Fish and Wildlife Service

Approve  Date 1-8-08

REGIONAL OFFICE APPROVAL:

Lead Regional Director, Fish and Wildlife Service

Approve  Date 1/10/08