Rorippa gambellii [*Nasturtium gambelii*]
(Gambel's watercress)

5-Year Review:
Summary and Evaluation

Photo by Mark A. Elvin, USFWS 2007

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

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5-YEAR REVIEW

Rorippa gambellii [*Nasturtium gambelii*] (Gambel's watercress)

I. GENERAL INFORMATION

Purpose of 5-Year Review:

The U.S. Fish and Wildlife Service (Service) is required by section 4(c)(2) of the Endangered Species Act (Act) to conduct a status review of each listed species at least once every 5 years. The purpose of a 5-year review is to evaluate whether or not the species' status has changed since it was listed (or since the most recent 5-year review). Based on the 5-year review, we recommend whether the species should be removed from the list of endangered and threatened species, be changed in status from endangered to threatened, or be changed in status from threatened to endangered. Our original listing of a species as endangered or threatened is based on the existence of threats attributable to one or more of the five threat factors described in section 4(a)(1) of the Act, and we must consider these same five factors in any subsequent consideration of reclassification or delisting of a species. In the 5-year review, we consider the best available scientific and commercial data on the species, and focus on new information available since the species was listed or last reviewed. If we recommend a change in listing status based on the results of the 5-year review, we must propose to do so through a separate rule-making process defined in the Act that includes public review and comment.

Species Overview:

Rorippa gambellii [*Nasturtium gambelii*] (Gambel's watercress) was listed as endangered on August 3, 1993 (Service 1993). There have been several taxonomic revisions for this species since that date and *R. gambellii* is currently recognized by the scientific name *Nasturtium gambelii* (see Changes in Taxonomic Classification or Nomenclature section below for reference to change in scientific name since listing.) We refer to this species throughout the rest of the document as *Nasturtium gambelii*. *Nasturtium gambelii* is a rhizomatous perennial herb in the Brassicaceae (mustard family) that can grow up to 6 feet (2 meters) tall. Historically, *N. gambelii* occurred in wetland locations in central and southern California (Orange, San Bernardino, Los Angeles, Santa Barbara, and San Luis Obispo Counties). At the time of listing in 1993, we stated in the final listing rule that there were three known *N. gambelii* populations: Black Lake Canyon, Oso Flaco Lake, and Little Oso Flaco Lake, all within San Luis Obispo County. All three populations have had no pure *N. gambelii* plants observed recently; all plants that have been observed are either introgressed with *N. officinale* [*Rorippa nasturtium-aquaticum*] (white or common watercress), or only pure *N. officionale* exist at the site. Pure *N. gambelii* is currently known from one remaining wild population, discovered in 1996, on Vandenberg Air Force Base (VAFB) in Santa Barbara County, California, and one population that was introduced in October 2008 on the Guadalupe-Nipomo Dunes National Wildlife Refuge (Refuge) in San Luis Obispo County, California. The threats to *N. gambelii* consist of loss and degradation of habitat due to development and urbanization; adverse effects from biostimulation (a state of excessive growth of vegetation caused by the addition of nutrients into an ecological system); sedimentation; inadequacy of existing regulatory mechanisms; nonnative species; stochastic (i.e., random) extirpation/extinction events due to the small size and isolation of the

remaining population; and genetic swamping from the closely related, introduced crop species, common watercress.

Methodology Used to Complete the Review:

This review was prepared by the Ventura Fish and Wildlife Office (VFWO), following the Region 8 guidance issued in March 2008. We used information from the recovery plan, survey information from experts who have been monitoring various localities of this species, and the California Natural Diversity Database (CNDDB) maintained by the California Department of Fish and Game. The recovery plan and personal communications with experts were our primary sources of information used to update the species' status and threats. This 5-year review contains updated information on the species' biology and threats, and an assessment of that information compared to that known at the time of listing. We focus on current threats to the species that are attributable to the Act's five listing factors. The review synthesizes all this information to evaluate the listing status of the species and provide an indication of its progress towards recovery. Finally, based on this synthesis and the threats identified in the five-factor analysis, we recommend a prioritized list of conservation actions to be completed or initiated within the next 5 years.

Contact Information:

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Cooperating Field Office: Gary Wallace, Botanist, Carlsbad Fish and Wildlife Office; (760) 431-9440.

Federal Register Notice Citation Announcing Initiation of This Review: A notice announcing initiation of the 5-year review of this taxon and the opening of a 60-day period to receive information from the public was published in the Federal Register (FR) on March 25, 2009 (74 FR 12878). No information was received in relation to this species.

Listing History:

Original Listing
FR Notice: 58 FR 41378
Date of Final Listing Rule: August 3, 1993
Entity Listed: *Rorippa gambellii* [*Nasturtium gambelii*]; a plant species
Classification: Endangered

State Listing
Rorippa gambellii was listed as threatened by the State of California in 1990.

Associated Rulemakings: N/A

Review History: N/A

Species' Recovery Priority Number at Start of 5-Year Review: The recovery priority number for *Nasturtium gambelii* is 2 according to the Service's 2008 Recovery Data Call for the Ventura Fish and Wildlife Office, based on a 1-18 ranking system where 1 is the highest-ranked recovery priority and 18 is the lowest (Endangered and Threatened Species Listing and Recovery Priority Guidelines, 48 FR 43098, September 21, 1983). This number indicates that the taxon is a species that faces a high degree of threat and has a high potential for recovery.

Recovery Plan or Outline

> **Name of Plan or Outline:** Recovery Plan for Marsh Sandwort (*Arenaria paludicola*) and Gambel's Watercress (*Rorippa gambelii*).
> **Date Issued:** September 28, 1998.

II. REVIEW ANALYSIS

Application of the 1996 Distinct Population Segment (DPS) Policy:

The Endangered Species Act defines species as including any subspecies of fish or wildlife or plants, and any distinct population segment (DPS) of any species of vertebrate wildlife. This definition limits listing as distinct population segments 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.

Information on the Species and its Status

Species Biology and Life History

Nasturtium gambelii is a rhizomatous perennial herb in the Brassicaceae (mustard family) that can grow up to 6 feet (2 meters (m)) tall. It roots at lower stem nodes, while the upper stem generally remains erect and it can produce adventitious roots on the trailing stems that come in contact with suitable conditions. It generally blooms from April to July, producing dense inflorescences (flower clusters) with white flowers. Lateral inflorescences may bloom through August and as late as October (Elvin 2005a). The petals are 0.23 to 0.31 inch (6 to 8 millimeters (mm)) long. The inflorescences generally produce 15 to 30 fruits with about 10 to 30 seeds each (Price 1989). The fruits are generally 0.59 to 0.98 inch (15 to 25 mm) long by 0.03 to 0.05 inch (0.8 to 1.2 mm) wide and have a single row of seeds.

Nasturtium gambelii's rhizomatous nature and its ability to root at the nodes can give the appearance that more individuals occur in any given population than actually do. A study was conducted to determine the genetic diversity of one population that was estimated to have 100 individuals. Out of the 77 wild-collected *Nasturtium* specimens tested, it was determined that there were 16 genetically distinct individuals; 51 of the specimens represent the same genetic individual (Prince 2008a, 2008b). Therefore, population estimates for *N. gambelii* based on

counts of aerial stems are likely to overestimate the actual number of genetically distinct individuals in any given population.

Distribution

In this review, we define various terms that are used for different assemblages of plants that we use in discussing the status of *Nasturtium gambelii*. In this review we use the term "occurrence" to be consistent with the definition used by the CNDDB: a grouping of plants within 0.25 mile (0.4 kilometer (km)) of each other. There can be one or more discrete polygons of plants mapped within a single "occurrence". We use the term "population" to refer to a group of interbreeding individuals, in the biological sense of the word. There can be (and usually are) one or more "occurrences" within a single population. Our use of the term "location" in previous documents for *N. gambelii* was interchangeable with "occurrence" and "population". In this review, "location" refers only to a particular site, area, or region, as in "at that location", with no specific relation to an assemblage of plants (e.g., polygon, occurrence, population). The terms "site," "area," and "region" refer to physical places.

Historically, *Nasturtium gambelii* occurred in cismontane regions (on the coastward side of the mountains) of central and southern California, in Orange, San Bernardino, Los Angeles, Santa Barbara, and San Luis Obispo Counties, California (Service 1993, 1998; Keil 1997; CNDDB 2009; California Native Plant Society (CNPS) 2009; Consortium of California Herbaria (CCH) 2009) (see Table 1 below). We stated in the final listing rule (Service 1993) that at that time there were three known *N. gambelii* populations: Black Lake Canyon, Oso Flaco Lake, and Little Oso Flaco Lake, all within San Luis Obispo County (Service 1993). All three populations have had no pure *N. gambelii* plants observed recently; all plants that have been observed are either introgressed with *N. officinale* [*Rorippa nasturtium-aquaticum*] (white or common watercress), or only pure *N. officionale* exist at the site. Pure *N. gambelii* is currently known from one remaining wild population, discovered in 1996, on Vandenberg Air Force Base (VAFB) in Santa Barbara County, California, and one location where it was introduced in October 2008 on the Guadalupe-Nipomo Dunes National Wildlife Refuge (Refuge) in San Luis Obispo County, California.

Several *Nasturtium* collections that have been identified as *N. gambelii* were made in the mid-1980s from montane valleys above 2,500 m (8,200 feet) in elevation in the state of Chiapas in the Valley of Mexico near Mexico City, approximately 1,500 miles (2,500 km) to the south-southeast of the southernmost location in California (Wickenheiser 1989, Service 1998, CONABIO 2009). Specimens on two herbarium sheets from the National Herbarium of Mexico were identified as belonging to *Rorippa gambellii* [*N. gambelii*] (Bailey 1998), but a recent examination of these specimens indicate that they are *N. officinale* and not *N. gambelii* (Bailey Hortorium 2009, Elvin 2009). Several other specimens in herbaria in Mexico are listed as *N. gambelii* (CONABIO 2009). However, it should be noted that (1) there is a considerable separation between the coastal plants along the Pacific Ocean between California and the montane plants from Mexico (more than 1,500 miles); (2) there is a difference in habitat and elevations (approximately 8,000 feet) between the California plants and those from Mexico; and (3) the first noted specimens identified as *N. gambelii* from Mexico were determined to have been mis-identified. Based on these facts, it is possible that the other specimens from Mexico were mis-identified as well, and may also represent *N. officinale* specimens. However, we have not analyzed the other specimens from Mexico and cannot say with certainty whether they are *N.*

gambelii or *N. officinale*. We do not discuss the Mexico specimens further in this review. *Nasturtium gambelii* is currently known from one remaining wild population discovered in 1996 on VAFB in Santa Barbara County, California (Keil 1997, CNDDB 2010), and one population that was introduced in October 2008 on the Refuge in San Luis Obispo County, California, both of which are on lands owned and managed by the federal government.

Abundance and Population Trends

In California floras by Hoover (1970), Munz (1974), and Rollins (1993), the abundance of *Nasturtium gambelii* was termed, respectively, "locally common," "occasional, becoming scarcer," and finally, "rare". In the 1980s *N. gambelii* was reported from three small, remaining populations, all within 4 miles (6.4 km) of each other, in San Luis Obispo County: Black Lake Canyon, Oso Flaco Lake, and Little Oso Flaco Lake. Due to the rhizomatous nature of this species, it is difficult to make an accurate population estimate. However, in 1989, about 700 individual plants were estimated to occur in these three populations combined: 100 at Black Lake Canyon and 300 at each of the two lakes (Price 1989). In 1992, about 1,000 individuals were reported at Black Lake Canyon; the other populations were not relocated (Service 1998). The Black Lake Canyon population was again reported in 1993, and was estimated to contain 500 individuals at that time (Service 1998). The same number of plants was reported from this site in July 1994 (Service 1998). Searches conducted in 1993 and 1994 failed to relocate the Oso Flaco Lake plants (Mazer and Waddell 1994; Service 1998). However, in 1994, about 500 *N. gambelii* plants were seen in shallow water at Little Oso Flaco Lake where Price had reported them in 1989 — in a drainage ditch next to agricultural fields along the north shore of the lake and west of this area along an extension that connects to the main part of the lake (Service 1998).

All three *Nasturtium gambelii* populations that were discussed in the final listing rule in 1993 (Black Lake Canyon, Oso Flaco Lake, and Little Oso Flaco Lake), are now considered to be "possibly extirpated" by the CNDDB (2010). In 1994 only two populations were considered to be extant (Wickenheiser and Morey 1990, CNDDB 1994). A May 1998 search of Oso Flaco Lake by John Chesnut (1998) found no plants in Price's location southwest of the Oso Flaco causeway, but did report a large occurrence north of the causeway, where he estimated that there were more than 400 plants. He observed a smaller occurrence on the east shore of the southern portion of the lake, where he reported that he counted 68 plants. He did not survey all potentially suitable habitat in the immediate vicinity at Oso Falco Lake. Chesnut did not find *N. gambelii* in any portion of Little Oso Flaco Lake during these surveys. The site in Little Oso Flaco Lake, where it had been reported from in 1989, was dredged in spring 1998. Vegetation had not re-established at the time of Chesnut's visit. In 2005, *N. officinale* and plants intermediate between *N. officinale* and *N. gambelii* (i.e., hybrid individuals) were observed at this site, but pure *N. gambelii* was not observed here (Elvin 2005b). Specimens collected from Oso Flaco Lake are annotated as appearing to be of hybrid origin dating back to at least 1963 (e.g., *Breedlove 5705* (CAS) California Academy of Sciences Herbaria 2009, CNDDB 2010). Genetic data suggest that all recent *Nasturtium* material collected from the Oso Flaco Lakes population represents material that contains genetic material from both *N. officinale* and *N. gambelii* (Mazer et al. 2000; Prince 2008a, 2008b). However, it is important to note that while there has been a large change in the vegetation at Oso Flaco Lake due to eutrophication (artificial or natural addition of substances, such as nitrates and phosphates, to an aquatic system), some suitable habitat still appears to exist there, and it is possible that some pure *N. gambelii* plants may still occur there. *Nasturtium gambelii* was last reported from the Black Lake Canyon population in 1994

(CNDDB 2010). There are no *N. gambelii* specimens in herbaria from Black Lake Canyon. No genetic tests have been conducted on *N. gambelii* from Black Lake Canyon (Mazer et al. 2000).

Pure *Nasturtium gambelii* plants are currently known from one remaining wild population on VAFB in Santa Barbara County, California (Keil 1997, CNDDB 2010), and one additional site where plants were introduced in October 2008 on the Refuge in San Luis Obispo County, California. Approximately 200 *N. gambelii* plants were planted at six ponds (32 plants at each pond) on the Refuge in October 2008. The plants have not fully established at this site, therefore, we do not consider this to be a viable population at this time and this population is not included in Table 1.

All recently examined *Nasturtium gambelii* plants at Oso Flaco Lake appear to be genetically compromised and introgressed with the locally abundant nonnative species *N. officinale* based on morphological and molecular evidence of hybridization (Mazer et al. 2000; Prince 2008a, 2008b; CAS 2009). The population (at VAFB) has some individuals that may be of hybrid origin (Prince 2008a, 2008b). Results from genetic tests indicate that two of the *N. gambelii* samples from the VAFB population share rare bands (markers that represent genes or alleles) with both the *N. officinale* sample used for the genetic test and the *Nasturtium* samples from Oso Flaco Lake, suggesting that two plants from VAFB may be of hybrid origin with *N. officinale* (Prince2008a, 2008b). If these two plants in the VAFB population are hybrid individuals, then there would be no known, wild populations of *N. gambelii* that are comprised entirely of *N. gambelii* plants.

Table 1: Population Records for *Nasturtium gambelii* collated from various sources.

CNDDB Element Occurrence Identification Number	Location Name, County	Current Status	Last Observed/ Documented	Presence/Year Surveyed	Reference
Oso Flaco Lakes population[1]					
1	Oso Flaco Lake (causeway, northeast and southern edges), San Luis Obispo	No pure *Nasturtium gambelii* plants observed recently. Last documented in 1949. All material and plants since then have exhibited some introgression with *N. officinale* (see discussion in Abundance, Population Trends section).	Last specimen pure *Nasturtium gambelii* collected from this occurrence in 1949. All collections and reports since then represent plants intermediate between *N. gambelii* and *N. officinale* (specimens from this occurrence show signs of introgression in specimens collected in 1962, 1963, 1986, and thereafter).	Present (1940) Present (1949) Introgressed specimen (1962) Introgressed specimen (1963) Introgressed specimen (1982) Reported (1984) Introgressed specimen (1986) Introgressed specimen (1987) Reported (1988) Reported (1989) 0 (1992) 0 (1993) 0 (1994) Introgressed specimen (1998) Introgressed specimen (1999) Introgressed specimen (2001) Introgressed specimen (2005)	*Nobs 851* (POM[2], UC[2]), *Nobs 852* (UC[2]), *Breedlove 4082* (CAS[2]), *Breedlove 5705* (CAS[2]), *Griffiths s.n.* (CDA[2]), *Griffiths 18248* (CDA[2]), *Jones s.n.* (SBBG[2]), *Parikh SLO-7* (SBBG[2]), *Parikh SLO-8* (SBBG[2]), *Parikh SLO-9* (SBBG[2]), *Elvin 4580* (IRVC[2]), Price 1989, Waddell 1993 (in Service 1998), Parikh 1994 (in Service 1998), CCH 2009, CNDDB 2010

9	Little Oso Flaco Lake (southern end) , San Luis Obispo	No pure *Nasturtium gambelii* plants observed recently. Last reported in 1994, only introgressed individuals or *N. officinale* observed recently.	1994	Reported (1985) Reported (1989) Reported (1993) Introgressed specimen (1994) 0 (1998) 0 (2005)	Price 1989, Waddell 1993 (in Service 1998), Elvin 2005b, Service 1998, CCH 2009, CNDDB 2010
Black Lake Canyon population					
10	Black Lake Canyon upstream, San Luis Obispo	No pure *Nasturtium gambelii* plants observed recently. Last reported in 1993, only introgressed individuals or *N. officinale* observed recently.	1993	Reported (1988) Reported (1992) Reported (1993) 0 (2005)	Price 1989, Elvin 2005c; Service 1998, CNDDB 2010
11	Black Lake Canyon 0.8 mi E of Hwy 1, San Luis Obispo	No pure *Nasturtium gambelii* plants observed recently. Last reported in 1994, only introgressed individuals or *N. officinale* observed recently.	1994	Reported (1993) Reported (1994) 0 (1998) 0 (1999) 0 (2005)	Waddell 1993 (in Service 1998); Elvin 2005c; Service 1998, CNDDB 2010
Cienega population					
7	Los Angeles Basin Region, Los Angeles	No pure *Nasturtium gambelii* plants observed recently. Last observed in 1904.	1904	Present (1885) Present (1892) Present (1904)	*Lyon s.n.* (DS[2]), *Nevin s.n.* (DS[2]), CCH 2009, CNDDB 2010
Huntington Beach population					
13	Huntington Beach (Huntington Harbor), Orange	No pure *Nasturtium gambelii* plants observed recently. Last observed in 1908.	1908	Present (1908)	*Condit s.n.* (UC[2]), Roberts 1998, CNDDB 2010
San Bernardino population					
4	San Bernardino Valley (Urbita Hot Springs), San Bernardino	No pure *Nasturtium gambelii* plants observed recently. Last observed in 1910.	1910	Present (1885) Present (1888) Present (1891) Present (1892) Present (1910)	*Parish 1130* (JEPS[2], RSA[2]), *Parish 3796* (UC[2]), *Parish 8005* (POM[2], UC[2], UCR[2]), CCH 2009, CNDDB 2010
Twin Lake population					
2	Twin Lake, San Luis Obispo	No pure *Nasturtium gambelii* plants observed recently. Last observed in 1947.	1947	Present (1947)	*Hoover 7345* (UC[2]), CCH 2009, CNDDB 2010
Vandenberg Air Force Base population[3]					
12	Tributary to San Antonio Creek, Santa Barbara	Last observed in 2007.	2007 (Elvin 2007)	Present (1996) Present (1998) Reported (1999) Present (2005) Reported (2007)	*Keil 25992* (OBI[2]); *Parikh VAFBMB-1* (SBBG[2]); *Elvin 4586* (CAS[2], IRVC[2]); Keil and Holland 1998; Elvin 2005a, 2007; Prince 2008a; CCH 2009; CNDDB 2010

Barka Slough population					
14	Barka Slough, Santa Barbara	No pure *Nasturtium gambelii* plants observed recently. Last reported in 1980, only introgressed individuals or *N. officinale* observed recently.	1980	Reported (1980) 0 (1995) 0 (2008)	Dial 1980, ManTech SRS Technologies 2008; CNDDB 2010
Santa Barbara population					
15	Santa Barbara (near the city of), Santa Barbara	No pure *Nasturtium gambelii* plants observed recently. Last observed in 1876.	1876	Present (1875) Present (1876)	*Rothrock s.n.* (GH[2]), *Gambel s.n.* (GH[2]), *Gambel s.n.* (GH[2]), *Rothrock 17* (GH[2]), Wilken 2009, CNDDB 2010
Oceano Beach population					
16	Arroyo Grande, San Luis Obispo	No pure *Nasturtium gambelii* plants observed recently. Last observed in 1949.	1949	Present (1949)	*Hoover 7725* (RSA[2], UC[2]), CCH 2009; CNDDB 2010

CNDDB identification # = occurrence number assigned by the California Natural Diversity Database (CNDDB 2010).

[1] Identity of individuals in this population uncertain due to observed introgression in part of this population.
[2] CAS – Herbarium of the California Academy of Sciences, CDA – California Department of Food and Agriculture Herbarium, DS – Dudley Herbarium at the California Academy of Sciences, GH – Gray Herbarium [Harvard University], JEPS – Jepson Herbarium at the University of California at Berkeley, POM – Herbarium of Pomona College at Rancho Santa Ana Botanic Garden, OBI – Robert F. Hoover Herbarium at California Polytechnic State University San Luis Obispo, RSA – Herbarium of Rancho Santa Ana Botanic Garden, UC – University Herbarium at the University of California at Berkeley, UCR – University of California Riverside Herbarium.
[3] Two individuals in the VAFB population may be introgressed with *N. officinale* (see Genetics section below).

Habitat or Ecosystem Conditions (e.g., amount and suitability)

Nasturtium gambelii is a coastal species that was historically known to occur in marshes and other perennially mesic areas (i.e., streams, creeks) from Arroyo Grande in central California (San Luis Obispo County) to the Santa Ana River in southern California (Orange and San Bernardino Counties). Relatively little is known about the habitat conditions at the historical locations while *N. gambelii* was present because there is little information on the herbarium specimens. In San Luis Obispo and Santa Barbara Counties, *N. gambelii* has been reported to grow in perennially swampy and other mesic areas with *Scirpus* spp. (bulrush), *Sparganium* sp. (bur-reed), *Berula erecta* (cutleaf water-parsnip), *Ribes divaricatum* var. *pubiflorum* (straggly gooseberry, straggle bush), *Toxicodendron diversilobum* (poison oak), *Salix* spp. (willow), and other riparian vegetation (Dial 1980, Chesnut 1998, Elvin 2005a, ManTech SRS Technologies (SRS) 2008, University of California at Berkeley Herbaria 2009).

As a whole, marsh habitat along the Pacific coast in California continues to decrease both in quantity and quality. These changes are attributed primarily to increased development and urbanization; adverse effects from biostimulation, eutrophication, erosion, and sedimentation; inadequacy of existing regulatory mechanisms; nonnative species; and stochastic (i.e., random) events (Service 1993, 1998; Mazer et al. 2000; Prince 2008a 2008b; CNDDB 2010; CNPS 2009). Biostimulation is generally characterized as a state of excess growth of vegetation due to

anthropogenic nutrient input into a system (California State Water Resources Control Board 2006a, California State Water Resources Control Board 2006b, Central Coast Ambient Monitoring Program 2002, Dodds et al. 1998). Biostimulation depends on a number of factors in addition to nitrogen and phosphorus concentrations such as dissolved oxygen, pH, shading or sunlight levels, temperature, and other factors (Creager et al. 2006).

Because we have little to no information regarding habitat conditions for this species, particularly from historical locations while they were occupied by *Nasturtium gambelii*, we only discuss the habitat conditions at sites where *N. gambelii* has occurred naturally since it was listed and while it was growing at those sites.

Black Lake Canyon

The habitat conditions in Black Lake Canyon have changed considerably since the listing. Several new development projects have been built in the Black Lake Canyon watershed and upstream of the historic populations. Most notable are: (1) the Cypress Ridge Golf Course and development, (2) Black Lake Canyon Golf Course, and (3) the expansion of the Greenhart Farms nursery production facility (Airphoto USA Inc. 2000, 2003; CNDDB 2007, 2009; Google Earth 2007 (aerial imagery dated April 2006)). Since these developments have been completed, the hydrologic patterns within Black Lake Canyon have changed. The subsurface recharge has decreased due to groundwater pumping to partially supply the developments (Land Conservancy of San Luis Obispo County 1992; Chipping 1994). At the same time, surface flows into Black Lake Canyon have increased in quantity and now include higher levels of herbicides, pesticides, and fertilizers (Land Conservancy of San Luis Obispo County 1992; Chipping 1994).

Vegetation in the Black Lake Canyon watershed is denser and more overgrown now than it was in the early 1990s (Anuja Parikh and Nathan Gale, pers. comm. 2007; Elvin 2005d; Mazer et al. 2000; Airphoto USA Inc. 2000, 2003; CNDDB 2007, 2009; Google Earth 2007; Land Conservancy of San Luis Obispo County 1992). While vegetation changes naturally over time in dynamic systems such as some riparian habitats, the vegetation changes in Black Lake Canyon are consistent with biostimulation (Dodds et al. 1998).

Additionally, *Eucalyptus* sp. (eucalyptus) trees surround much of the canyon and cover much of the watershed of Black Lake Canyon. Because eucalyptus trees consume large amounts of water, they have contributed to lowering the water table in the canyon bottom (Chipping 1994). In 1996, approximately 2.5 acres (1.0 hectare) of eucalyptus were removed with an unknown effect to the water table in the canyon (Land Conservancy of San Luis Obispo County 1992). However, dozens of acres of eucalyptus still remain in the Black Lake Canyon watershed (Airphoto USA Inc. 2000, 2003; Google Earth 2007; Elvin 2005d).

Oso Flaco Lake and Little Oso Flaco Lake

The habitat at Oso Flaco Lake and Little Oso Flaco Lake has been recorded as declining in quality and quantity (CNDDB 2009, 2010). The vegetation here recently has become thicker, denser, and more overgrown than in the early 2000s (Airphoto USA Inc. 2000, 2003; Elvin 2005d; CNDDB 2009, 2010; Google Earth 2007). Indirect effects from urbanization and development, as well as agricultural operations upstream from the lake, have added to the decline in quality of this marsh and swamp habitat (i.e., increases in nutrients, type conversion of habitat, biostimulation) (Service 1993; Chesnut 1998; Airphoto USA Inc. 2000, 2003; Land Conservancy

of San Luis Obispo County 1992; California State Water Resources Control Board 2006a, 2006b; Central Coast Ambient Monitoring Program 2002). The changes in vegetation at Oso Flaco Lake and Little Oso Flaco Lake are also consistent with biostimulation (Dodds et al. 1998).

Vandenberg Air Force Base
Nasturtium gambelii has been reported from two locations at VAFB: Barka Slough (historical) and a tributary to San Antonio Creek (currently occupied) (Dial 1980, Keil 1997, SRS 2008). The habitat at Barka Slough has been recorded as declining in quality and quantity. Historically, the emergent vegetation at Barka Slough was much more extensive. Much of the marshland is transitioning to *Salix* spp. and *Urtica dioica* (stinging nettle) and the water table is also dropping (SRS 2008).

Changes in Taxonomic Classification or Nomenclature
Nasturtium gambelii was originally described as *Cardamine gambellii* in 1876 based on a specimen collected by William Gambel in 1844 in the vicinity of Santa Barbara (Watson 1876). *Nasturtium gambelii*, the currently recognized name, was originally listed by the Service as endangered under the name *Rorippa gambellii* (Service 1993). While the circumscription of the species (the limits of the species characters and range) has remained constant since its original description, it has been recognized under several different names (some of the names have similar spelling, but because they were recorded with slightly different names they are listed separately), including *Cardamine gambellii* (Watson 1876, Abrams 1944), *Cardamine gambelii* (Jepson 1923; Munz 1959, 1968, 1970, 1974; Hoover 1970; Roberts 1989), *Rorippa gambelii* (Smith 1976, 1998; Roberts 1998; Service 1998, CNPS 2001), *Rorippa gambellii* (Al-Shehbaz and Rollins 1988, Rollins 1993, Service 1993, Skinner and Pavlik 1994), *Nasturtium gambellii* (Al-Shehbaz and Price 1998), and *Nasturtium gambelii* (Index of California Plant Names 2009).

Genetics
There have been two studies since the time of listing that analyzed the genetics of *Nasturtium gambelii*; one by Mazer, Parikh, and Gale (2000) and one by Prince (2008a, 2008b).

Mazer et al. (2000) investigated the genetic variation within and between *N. gambelii* populations. Their results indicate that all of the *Nasturtium* specimens that they tested from Oso Flaco Lake contained genetic sequences from both *N. gambelii* (*R. gambellii*) and *N. officinale* (*R. nasturtium-aquaticum*). They additionally noted that plants from Oso Flaco Lake displayed a number of morphological characters intermediate between *N. gambelii* and *N. officinale* (e.g., flower size, seed morphology, leaf morphology). They concluded that the genetic data "…strongly supports the hypothesis that the Oso Flaco plants are of hybrid origin" (Mazer et al. 2000).

The Prince study in 2008 investigated genetic diversity within *Nasturtium gambelii* and attempted to identify all distinct genotypes that were represented by the 78 individuals sampled (Prince 2008a, 2008b). The study determined that there were 18 genotypes among the 72 *Nasturtium* samples from VAFB, 5 genotypes among the 5 *Nasturtium* samples from Oso Flaco Lake, and 1 genotype from the 1 sample of *N. officinale* (this last sample was used as an outgroup) from a cultivated source (Prince 2008a, 2008b). Prince determined that all of the samples from Oso Flaco Lake share seven alleles with the *N. officinale* sample and hypothesized

that all of the Oso Flaco Lake samples are introgressed with *N. officinale*. Prince determined that the likelihood that the Oso Flaco Lake samples shared that much genetic material with the *N. officinale* sample, but not with any of the VAFB samples, by chance alone is exceedingly small ($2^7/2^{62} = 2.77 \times 10^{-17}$). Additionally, she determined that two of the VAFB specimens, which represent genetically unique individuals, share rare alleles with *N. officinale*, may be introgressed with *N. officinale*, and therefore should not be used for propagation of plants (Prince 2008a). This results in a determination that there are a total of 16 genetically distinct individuals of *N. gambelii* in the 77 wild collected *Nasturtium* samples that were tested (plus one *N. officinale* control sample). Among other things, these data indicate that all previous population estimates are likely to be considerably higher than the actual number of genetically unique individuals at any given *N. gambelii* occurrence or population and that there are very few genetically distinct individuals of this species remaining.

Species-specific Research and/or Grant-supported Activities

The Service contributed $31,200 in section 6 funding (funding provided by the Service to States pursuant to section 6 of the Act) between April 1998 through December 1999 for a study of field observations, greenhouse cultivation, molecular genetic variation, and trial reintroductions. This study resulted in the Mazer et al. report (2000). In 2007, the Service contributed $65,000 towards recovery projects for *Nasturtium gambelii* and the federally endangered *Arenaria paludicola* (marsh sandwort). The Service also contributed staff time to these recovery projects from 2007 through 2010. The projects included surveys of historical locations and for suitable habitat locations, *ex situ* propagation, an introduction effort at the Refuge, and the development and implementation of a monitoring plan for the outplanting efforts at the Refuge.

Five-Factor Analysis

FACTOR A: Present or Threatened Destruction, Modification, or Curtailment of Habitat or Range

In the final rule to list the species (Service 1993), we stated in the Factor A discussion that threats to the continued existence of *Nasturtium gambelii* consisted of alteration of the hydrological regime, modification of habitat at Oso Flaco Lake due to encroachment of sand from adjacent dunes, and lack of a permanent water source at Little Oso Flaco Lake. These threats to the species have not diminished.

Since the time of listing, there has been a loss and degradation of habitat due to development and urbanization and a conversion of marsh habitat due to the collateral, but indirect, effects from development and urbanization. Some of this habitat loss has occurred in watersheds that are classified as impaired by the Regional Water Quality Control Board due to excessive amounts of nitrogen and other nutrients (California State Water Resources Control Board 2006a). The vegetation in these watersheds exhibits excessive growth that is consistent with biostimulation and eutrophication (California State Water Resources Control Board 2006a, California State Water Resources Control Board 2006b, Central Coast Ambient Monitoring Program 2002, Dodds et. al. 1998). The excessive growth of some vegetation (e.g., willows, bulrush, *Typha* (cattails)) causes type conversion of habitat (such as at Black Lake Canyon and Oso Flaco Lake) and a decline in the quantity and quality of habitat suitable for *Nasturtium gambelii*.

Most of the historical populations and their surrounding areas are urbanized and/or indirectly impacted by urbanization, which has further limited this species' ability to colonize adjacent suitable habitat. These conditions also limit sites and opportunities for successful introductions and reintroductions.

In summary, threats to *Nasturtium gambelii* under Factor A that were discussed in the final rule to list the species have not diminished and additional threats have been identified or have developed since that time, particularly the loss and degradation of habitat and biostimulation due to nutrient loading.

FACTOR B: Overutilization for Commercial, Recreational, Scientific, or Educational Purposes

In the final rule to list the species (Service 1993), we stated in the Factor B discussion that overutilization was not known to be a factor/threat to this species (i.e., *Nasturtium gambelii* was not known to be sought after by collectors), but the species was thought to be vulnerable to this threat because of its limited distribution. There are no data to indicate that overutilization is currently a threat.

FACTOR C: Disease or Predation

In the final rule to list the species (Service 1993), we stated in the Factor C discussion that disease or predation was not known to be a threat to *Nasturtium gambelii*. Herbivory has been noted on plants at the introduced site on the Refuge (M.A. Elvin, pers. obs. 2009) and on plants under propagation at University of California, Irvine (UCI) Arboretum (Barry Nerhus, U.C. Irvine, pers. comm. 2006). While this plant may be able to withstand some herbivory, the herbivory may cause a reduction in its reproductive success due to the loss of flowers and the corresponding reduction in the production of seeds. The extent of this threat is not known, but the loss of even a few flowers due to herbivory, if it led to an even slight decrease in reproductive success, may have a significant effect on the long-term survival of *N. gambelii* because there are so few individuals remaining in the wild. Therefore, the relative threat from predation is greater now than was thought to be the case at the time of listing, because there are fewer populations and fewer individuals per population than at the time of listing.

FACTOR D: Inadequacy of Existing Regulatory Mechanisms

In the final rule to list the species (Service 1993), we stated in the Factor D discussion that regulatory mechanisms thought to have some potential to protect *Nasturtium gambelii* included: (1) listing under the California Endangered Species Act (CESA); (2) section 404 of the Clean Water Act; and (3); local land use laws, regulations, and policies. The listing rule (Service 1993) provides an analysis of the level of protection that was anticipated from those regulatory mechanisms. This analysis remains valid.

<u>Local Regulatory Mechanisms</u>

At the time of listing, we discussed that the County of San Luis Obispo had designated Black Lake Canyon as a Sensitive Resource Area. An enhancement management plan was prepared for the area (Land Conservancy of San Luis Obispo County 1992); however, the plan was never

adopted by the County, and therefore potential benefits to sensitive resources (such as removing eucalyptus, restoring native vegetation to certain portions of the canyon, and minimizing large development projects in the watershed) that would have resulted from management guidelines have not been realized. Our current analysis of protections afforded by local regulations remains the same as that at the time of listing, that they are inadequate for the protection of this species.

State Regulatory Mechanisms

Nasturtium gambelii was listed as endangered by the State of California in 1990. As such, projects that would affect *N. gambelii* are subject to CESA and California Environmental Quality Act (CEQA) requirements. The conservation of listed species through CEQA is dependent upon the discretion of the lead agency involved. To the best of our knowledge, no projects that have been subject to CESA or CEQA have been proposed with impacts to *N. gambelii* since it was listed.

California Coastal Act

The California Coastal Commission (CCC) considers the presence of listed species in determining environmentally sensitive habitat lands subject to section 30240 of the California Coastal Act of 1976, which requires their protection. Its mission is to protect, conserve, restore, and enhance environmental and human-based resources of the California coast and ocean for environmentally sustainable and prudent use by current and future generations (CCC 2010). Certain local jurisdictions have developed their own Local Coastal Programs (LCP) or Land Use Plans that have been approved by the CCC. The County of Santa Barbara has developed its own LCP (the Santa Barbara County Coastal Plan), which was partially certified by the CCC in March 1981. The historical distribution for *Nasturtium gambelii* occurs within the area covered by several local coastal plans. Proposed projects that are not exempt and occur within the jurisdictions of these LCPs would need to obtain approval from the local regulating jurisdiction. Protection of listed species through these LCPs is dependent upon the discretion of the local regulating jurisdiction. We are not aware of any specific circumstances where protections have been afforded to *N. gambelii* as a result of individual project review by any of the LCPs or the CCC; however, proposed projects that may have been revised to avoid adverse effects to sensitive species would not necessarily come to our attention. Additionally, State and local regulations may not protect *N. gambelii* from secondary impacts that occur from such threats as development in adjacent areas and the spread of nonnative species.

Federal Regulatory Mechanisms

Clean Water Act

The purpose of the Clean Water Act is to restore and maintain the chemical, physical, and biological integrity of the Nation's waters. Various sections of the Clean Water Act may provide protections for listed species by protecting or improving water quality and wetlands.

Section 303 of the Clean Water Act requires states, territories, and tribes to develop lists of impaired waters that do not meet minimum water quality standards. Section 303 also requires the development of Total Maximum Daily Loads (TMDLs) for water pollutants that do not meet established minimum standards. TMDLs attempt to list all sources of the pollutant and identify the maximum amount of a pollutant that can be discharged into a water body, while remaining within the established water quality criteria. TMDLs also develop allocations of the pollutant load among all of the dischargers that are contributing to the degradation of a water body, and

lists implementation steps necessary to ensure the allocations are met. While this system is managed by the Environmental Protection Agency, the State of California is authorized to implement this program within California. Section 303 may provide protections for listed species by requiring the identification of waters that do not meet water quality standards; identifying the sources of the water pollution; and setting a limit on the amount of pollution that each source can contribute to the water body, while still meeting the established water quality standards.

Section 401 of the Clean Water Act requires any applicant for a federal license or permit that will conduct any activity including, but not limited to, the construction or operation of facilities, which may result in any discharge into the navigable waters to certify with the State that any such discharge into waters will comply with water quality regulations promulgated by the State pursuant to the Clean Water Act. Certification under Section 401 is only issued if the proposed discharge would not cause or contribute to the exceedance of water quality standards. While this system is managed by the Environmental Protection Agency, the State of California is authorized to implement this program within California. Section 401 may provide protections for listed species by ensuring that discharges from federally licensed or permitted activities would not cause water quality to become degraded below criteria adopted by the State pursuant to the Clean Water Act. If the Act's protections for *Nasturtium gambelii* were removed, there would be no impact on requirements for Section 401 certification.

Section 402 of the Clean Water Act governs National Pollution Discharge Elimination System permits from a point source. While this system is managed by the Environmental Protection Agency, the State of California is authorized to implement the program within California. This means the State of California issues permits for discharges into waters directly to the discharging facilities. These permits require the use of "best management practices" to reduce pollutants to the "maximum extent practicable". Section 402 may provide protections for listed species by ensuring that facilities which discharge from a point source would not cause water quality to become degraded below criteria adopted by the State pursuant to the Clean Water Act.

Section 404 of the Clean Water Act is jointly administered by the U.S. Army Corps of Engineers and the Environmental Protection Agency and regulates the discharge of fill material into waters of the United States, which include navigable and isolated waters, headwaters, and adjacent wetlands (33 U.S.C. 1344). In general, the term "wetland" refers to areas meeting the Corps' criteria of hydric soils, hydrology (either sufficient annual flooding or water on the soil surface), and hydrophytic vegetation (plants specifically adapted for growing in wetlands). Any action with the potential to impact waters of the United States must be reviewed under the Clean Water Act. This review requires consideration of impacts to listed species and their habitats, and recommendations for mitigation of significant impacts. If a project falls within Corps jurisdiction and the Corps determines that listed species may be affected by project activities, interagency consultation (pursuant to section 7 of the Act) between the Service and Corps would occur to address the effects.

The Corps interprets "the waters of the United States" expansively to include not only traditional navigable waters and wetlands, but also other defined waters that are adjacent or hydrologically connected to traditional navigable waters. However, recent Supreme Court rulings have called into question this definition. On June 19, 2006, the U.S. Supreme Court vacated two district

court judgments that upheld this interpretation as it applied to two cases involving "isolated" wetlands. Currently, Corps regulatory oversight of such wetlands (e.g., vernal pools) is in doubt because of their "isolated" nature. In response to the Supreme Court decision, the Corps and the U.S. Environmental Protection Agency (USEPA) have recently released a memorandum providing guidelines for determining jurisdiction under the Clean Water Act. The guidelines provide for a case-by-case determination of a "significant nexus" standard that may protect some, but not all, isolated wetland habitat (USEPA and Corps 2007). The overall effect of the new permit guidelines on loss of isolated wetlands, such as vernal pool habitat, is not known at this time. At the time of listing, we determined that since there was little to no regulation of fill in the range of *Nasturtium gambelii* because most of the areas were less than 10 acres in size (58 FR 41378), the protections under section 404 were inadequate; although the Corps' implementation of these regulations has changed since then, there does not appear to have been any change in the level of protections afforded to *N. gambelii* under section 404.

Federal Endangered Species Act

Section 7(a)(2) of the Endangered Species Act requires Federal agencies to consult with the Service to ensure any project they fund, authorize, or carry out does not jeopardize federally listed species or destroy or adversely modify designated critical habitat. Section 9 of the Act and Federal regulations pursuant to section 4(d) of the Act prohibit the take (to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct) of federally endangered wildlife; however, the take prohibition does not apply to plants. 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 or in the course of any violation of a State criminal trespass law. Federally listed plants may be incidentally protected if they co-occur with federally listed wildlife species.

Since the time of listing, the Service has conducted one consultation pursuant to section 7 of the Act (a non-jeopardy biological opinion issued to the U.S. Forest Service) that addressed *Nasturtium gambelii* (Service 2000). There are no completed habitat conservation plans (HCP) that include *N. gambelii* as a covered species. *Nasturtium gambelii* has been proposed as a covered species in a draft HCP being developed by the California Department of Parks and Recreation for the Oceano Dunes State Vehicular Recreation Area.

Sikes Act

The Sikes Act (16 U.S.C. 670) authorizes the Secretary of Defense to develop cooperative plans with the Secretaries of Agriculture and the Interior for natural resources on public lands. The Sikes Act Improvement Act of 1997 requires Department of Defense installations to prepare Integrated Natural Resource Management Plans (INRMPs) that provide for the conservation and rehabilitation of natural resources on military lands consistent with the use of military installations to ensure the readiness of the Armed Forces. INRMPs incorporate, to the maximum extent practicable, ecosystem management principles and provide the landscape necessary to sustain military land uses. While INRMPs are not technically regulatory mechanisms because their implementation is subject to funding availability, they can be an added conservation tool in promoting the recovery of endangered and threatened species on military lands. Vandenberg Air Force Base recently completed an INRMP with the advice from the Service that includes

Nasturtium gambelii. This INRMP outlines protections for the known population on VAFB; specifically, the area has recently been fenced, and identified as an area restricted to entry. The area will not be used for development, but access for removal of unexploded ordnance or other unforeseen circumstances may be required in the future. However, despite the INRMP and the protection provided, the species continues to face threats from natural causes on VAFB and throughout its historical range.

In summary, from the time of listing until recently, existing regulatory mechanisms appear to have done little to ameliorate threats to *Nasturtium gambelii*, and substantial threats remain; however, recent efforts to improve protections may provide additional benefit to the species in the future. Other Federal and State regulatory mechanisms (e.g., CEQA, California Coastal Act) provide discretionary protections for the species based on current project review and permitting practices.

FACTOR E: Other Natural or Manmade Factors Affecting Its Continued Existence

In the final rule to list the species (Service 1993), we stated in the Factor E discussion that there were potential threats to the existence of *Nasturtium gambelii* from: (1) stochastic (i.e., random) extirpation/extinction events due to the small size and isolation of the remaining population; (2) other natural or manmade factors, such as flood, drought, or disease; and (3) competition with nonnative species. Below we review the status of these three threats. In addition, we discuss threats that have been identified since the time of listing: nutrient loading in watersheds, climate change and genetic swamping.

Small Population Size

The conservation biology literature commonly notes the vulnerability of taxa known from very few locations or from small and highly variable populations (e.g., Shaffer 1981, 1987; Primack 2006; Groom et al. 2006). The small size of the gene pool of the species (Mazer et al. 2000) may depress reproductive vigor, or increase the likelihood that a single human-caused or natural environmental disturbance (e.g., flood, drought, disease) could cause the extinction of *Nasturtium gambelii*. Small populations are threatened by inbreeding depression (Ellstrand and Elam 1993). Small plant populations can have significantly lower germination rates than larger populations of the same species due to high levels of homozygosity (having identical pairs of alleles for any given gene), which could result in the expression of disadvantageous traits (Menges 1991). Genetic stochasticity results from changes in gene frequencies due to founder effect, random fixation, or inbreeding (Shaffer 1981). The low levels of genetic variation among and within populations could impair the species' ability to adapt to changes in the environment or contribute to inbreeding depression (i.e., loss of reproductive fitness or vigor). The existence of less than five populations and the small number of individuals in these populations places *Nasturtium gambelii* at extreme risk of extinction due to low levels of genetic diversity.

Other Natural or Manmade Factors

Natural catastrophes such as fire, landslide, or prolonged drought could result in the loss of populations (Shaffer 1981), particularly for species with fewer than five populations. An increase in urban development has reduced the range of *Nasturtium gambelii* considerably. Indirect effects from urbanization in the watershed include changes in hydrology, changes in vegetation, and an increase in nonnative species. Increasing development in the area will likely

increase threats from stochastic events. We believe that the existence of one known wild population and the small number of individuals in the population exacerbate the risk of extinction to *Nasturtium gambelii* from stochastic events.

Competition with Nonnative Species

The effects of competition with nonnative species are most problematic immediately adjacent to urban areas and in habitat that has been isolated or fragmented by development (Alberts et al. 1993). These factors may not be enough to threaten the survival of *Nasturtium gambelii* independently, but taking into account its limited range, the cumulative and synergistic effects of all of these factors combined could be a threat to the survival and recovery of *N. gambelii*.

Nutrient Loading in Watersheds

Threats identified since the time of listing discussed above under Factor A include excessive amounts of nitrogen and other nutrients in watersheds that either currently support or historically supported *Nasturtium gambelii*. These nutrient levels can cause excessive growth of vegetation (biostimulation) in some species that may out-compete *N. gambelii* plants. The excessive growth of other vegetation (both native and nonnative) can have direct effects on *N. gambelii* individuals. The other plants can outcompete *N. gambelii* individuals for essential physical and biological elements (i.e., space for growth, food, water, light, minerals). This stress likely effects the survival of some individual plants or occurrences and increases the impact of threats to the species from stochastic events.

Climate Change

At the time of listing *Nasturtium gambelii*, we did not discuss the potential effects of climate change on its long-term persistence (Service 1993). Current climate change predictions for terrestrial areas in the Northern Hemisphere indicate warmer air temperatures, more intense precipitation events, a rise in sea level, and increased summer continental drying (Field et al. 1999, Cayan et al. 2005, Intergovernmental Panel on Climate Change 2007). The potential impacts of climate change on the distribution of plant species in California were discussed by Loarie et al. (2008). However, predictions of climatic conditions for smaller sub-regions such as coastal California remain uncertain. It is unknown at this time if climate change along the California coast will result in a warmer trend with localized drying, higher precipitation events, a higher frequency of fog, or other effects. The extent to which climate change could affect *N. gambelii* is unknown at this time due to the general nature of these predictions.

Despite the uncertainty regarding the specific effects of climate change on this species, an increase in the rate of sea level rise (SLR) has been predicted for the coast of California (CCC 2001, California Climate Change Center 2006, Heberger et al. 2009). Sea level rise is a result of two phenomena: thermal expansion (increased sea water temperatures) and global ice melt (Cayan et al. 2006). Between 1897 and 2006, the observed SLR has been approximately (0.08 inch (2 mm) per year, or a total of 8 inches (20 cm) over that period (Heberger et al. 2009). Older estimates projected that SLR along the California coast would follow a similar rate and reach 0.7-2 feet (0.2-0.6 m) by 2100 (Intergovernmental Panel on Climate Change 2007). Recent observations and models indicate that those projections were conservative and ignored some critical factors, such as melting of the Greenland and Antarctica ice sheets (Heberger et al. 2009). Heberger et al. (2009) have updated the SLR projections for California to 3.3-4.6 feet (1.0-1.4 m) by 2100, while Vermeer and Rahmstorf (2009) calculate the SLR globally at 2.4-6.2

feet (0.57-1.9 m); in both cases, more than twice the original projections. Combined with California's normal dramatic tidal fluctuations and coincidental storms, the severity of the latter increasing with climate change, the effects of SLR are expected to reach farther inland than previously anticipated (Cayan et al. 2006, Cayan et al. 2009). We note that the projections for storm severity increase to the north and decrease to the south, likely a consequence of the winter storm track shifting to the north (Cayan et al. 2009).

Park et al. (1989) projected that of the saltmarshes along the coast of the contiguous United States, 30 percent would be lost with a 1.6-foot (0.5-m) SLR, 46 percent with a 3.3-foot (1-m) SLR, 52 percent with a 6.6-foot (2-m) SLR, and 65 percent with a 9.8-foot (3-m) SLR. While we cannot project directly to California from the estimates of Park et al. (1989) who focused on the east coast and Gulf coast of the United States, we can anticipate that with a projected SLR of up to almost 6.6 feet (2 m) that much of the coastal saltmarshes in California would be lost by 2100. Beaches, dunes, and coastal areas would be subject to greater and more frequent wave attack, with a general rule of thumb that 50 to 100 feet (15 to 30 m) of beach width will be lost from use for every foot of sea level rise by the year 2100 (CCC 2001, Heberger et al. 2009). This is estimated to result in erosion and shoreline retreat between 459 and 1,083 feet (140 and 330 m), corresponding to an estimated loss of approximately 1.4 square miles (896 acres) of dunes in San Luis Obispo County by the year 2100 (CCC 2001, Heberger et al. 2009). Because *Nasturtium gambelii* historically occurred in coastal dune habitats throughout its range, erosion of these areas caused by an estimated rise in sea level could cause a loss of individual plants and seed banks for this species.

Genetic Swamping

Genetic swamping in *Nasturtium gambelii* is discussed above in the Genetics and Distribution sections. The *N. gambelii* plants at Oso Flaco Lake appear to be genetically compromised and introgressed with the locally abundant nonnative species *N. officinale* based on morphological and molecular evidence of hybridization (Mazer et al. 2000; Prince 2008a, 2008b; CNDDB 2009, 2010; CNPS 2009). The *N. gambelii* population (at VAFB) has at least two individuals that may be of hybrid origin with *N. officinale* (Prince 2008a, 2008b). The introgression of *N. gambelii* plants at Oso Flaco Lake and the potential introgression of two *N. gambelii* plants at VAFB (Mazer et al. 2000; Prince 2008a, 2008b; CNDDB 2009, 2010; CNPS 2009) suggest the species is in danger of extinction.

In summary, threats under Factor E that were discussed in the final rule to list the species continue to increase and additional threats have been identified or have developed since that time, particularly those related to nutrient loading in watersheds, small population size, competition from nonnative species, and genetic swamping.

III. RECOVERY CRITERIA

Recovery plans provide guidance to the Service, States, and other partners on ways to minimize threats to listed species and on criteria that may be used to determine when recovery is achieved. There are many paths to accomplishing recovery of a species and recovery may be achieved without fully meeting all recovery plan criteria. For example, one or more criteria may have been exceeded while other criteria may not have been accomplished. In that instance, we may determine that, over all, the threats have been minimized sufficiently, and the species is robust

enough, to reclassify the species from endangered to threatened or perhaps to delist it. In other cases, new recovery opportunities unknown at the time the recovery plan was finalized may be more appropriate. Likewise, new information may change the extent that criteria need to be met for recognizing recovery of the species. Overall, recovery is a dynamic process requiring adaptive management, and assessing a species' degree of recovery is likewise an adaptive process that may, or may not, fully follow the guidance provided in a recovery plan. We focus our evaluation of species status in this 5-year review on how progress toward achieving recovery criteria has contributed to eliminating or reducing the listing threats discussed in the five-factor analysis.

Since listing in 1993 and publication of the recovery plan in 1998, the status of *Nasturtium gambelii* has continued to decline. In 1998 we stated in the recovery plan that there were three *N. gambelii* populations (Service 1998). Pure *N. gambelii* plants are known from only one remaining wild population that occurs on VAFB in Santa Barbara County, California (Keil 1997; Mazer et al. 2000; Prince 2008a, 2008b; CNDDB 2010), however, this population may be showing signs of introgression with the nonnative invasive, *N. officinale* (Prince 2008a, 2008b).

The status of *Nasturtium gambelii* is so critical that the interim objective for it is to prevent its extinction (Service 1998). The interim downlisting criteria (Service 1998) for *N. gambelii* consist of the following:

1) Establish new plants so that there are at least 5 populations of at least 500 individuals.

This criterion addresses Listing Factors A, D, and E. While this criterion is appropriate, we do not believe that it is practical and it may not be attainable for several reasons: (1.) there are very few genetically distinct *Nasturtium gambelii* individuals remaining (less than 20); (2.) much of the habitat for this species has been lost, modified, or fragmented; (3.) there are few places left that could support *N. gambelii* populations of this size; and (4.) because of the widespread invasion of *N. officinale*, any introductions would likely eventually be lost through hybridization with *N. officinale*. Therefore, it is not likely that we will be able to get multiple populations with that many individuals. We have assembled a Scientific Recovery Implementation Team to help provide input for the Service to make a more accurate determination regarding the number of populations and individuals that are necessary to recover this species or if it is possible to recover this species.

2) Some populations occur in permanently protected habitats in Black Lake Canyon and the dune lakes area.

This criterion addresses Listing Factors A, D, and E. While this criterion is appropriate, we do not believe that it is attainable in the near future, because we may not be able to successfully introduce this species back into the wild for the reasons discussed in Criterion 1 above. If it can be introduced, most, if not all, of the sites are expected to occur on permanently protected lands.

3) Some populations must be in other areas of suitable habitat within the species' historical range in the United States.

This criterion addresses Listing Factors A, D, and E. While this criterion is reasonable and appropriate, we do not believe that it is attainable because of the widespread invasion of *Nasturtium officinale* which hybridizes with *N. gambelii*. We are working to determine if there are any remaining sites that are defensible (from *N. officinale* and other threats) throughout the historical range of the species. We introduced this species at the Refuge in October 2008. We intend that the Scientific Recovery Implementation Team will provide input to help us make a more accurate determination regarding whether there are reasonable and defensible introduction sites throughout the historical range of this species.

4) The [introduced] populations remain viable for at least 5 years (addresses Listing Factors A, D, and E).

We introduced *Nasturtium gambelii* at the Refuge in October 2008 from material taken from the VAFB population by planting just under 300 plants at 8 sites. Approximately one-third of the individuals were surviving as of June 2009, with approximately 100 individuals observed throughout all of the 8 sites. It was estimated that approximately 13 individuals were blooming at this time. It is too early to determine if this population will remain viable for the target 5 years (Elvin, M., pers. obs., 2009).

IV. SYNTHESIS

The status of *Nasturtium gambelii* has continued to decline since the time of listing in 1993. At the time of listing, it was known from three wild populations. All three populations have had no pure *N. gambelii* plants observed recently; all plants that have been observed are either introgressed with *N. officinale* [*Rorippa nasturtium-aquaticum*] (white or common watercress), or only pure *N. officionale* exist at the site. Pure *Nasturtium gambelii* plants are currently only known to occur at one wild population (on VAFB). Additionally, *N. gambelii* was introduced at one site in October 2008 (on the Guadalupe-Nipomo Dunes National Wildlife Refuge); ongoing monitoring will determine if the outplanting is successful. The VAFB population has a small number of individuals and this places *N. gambelii* at extreme risk of extinction from stochastic events. Additionally, it continues to face a number of threats, such as genetic swamping from the widespread and common invasive species *N. officinale*. While none of the recovery criteria have been fully met, we have made some progress on all of them. We are determining whether to continue efforts to introduce this plant to additional sites throughout its historical range.

Nasturtium gambelii still faces a high degree of threat and has little potential for recovery. As a consequence, we recommend changing the Recovery Priority Number as indicated below. We conclude that this taxon continues to be in danger of extinction throughout its currently known range and therefore continues to meet the definition of endangered under the Act; therefore, no status change is recommended at this time.

V. RESULTS

Recommended Listing Action:

____ Downlist to Threatened
____ Uplist to Endangered
____ Delist (indicate reasons for delisting per 50 CFR 424.11):
  ____ *Extinction*
  ____ *Recovery*
  ____ *Original data for classification in error*
_X_ No Change

New Recovery Priority Number and Brief Rationale: 5. We assign a new recovery priority number of 5. This number indicates that the taxon is a species facing a high degree of threat with a low potential for recovery. As of 2011, based on the threats described in this review, recovery seems unlikely for *Nasturtium gambelii*.

VI. RECOMMENDATIONS FOR ACTIONS OVER THE NEXT 5 YEARS

1. Work with the U.S. Air Force at Vandenberg Air Force Base to implement site-specific management activities in the immediate future to avoid and alleviate threats (such as from stochastic events) to prevent the loss of the last, known remaining wild population.

2. Work with others to establish new populations in the near future to reduce the risk of extinction to *Nasturtium gambelii* in each of the two ecological regions of its historical range in California (coastal central California and coastal southern California).

3. Work with others to establish and maintain *ex situ* stock populations with at least one institution in each of the three ecological regions of its historical ranges.

4. Work with the Central Coast Regional Water Quality Control Board to determine nutrient levels in the watersheds which historically supported *Nasturtium gambelii* in the recent past (particularly Black Lake Canyon and Oso Flaco Lake) to determine what may have led to the loss of *N. gambelii* form these sites, and work with local landowners and stakeholders to alleviate (and remove) any threats to *N. gambelii* that are associated with water quality.

5. Continue genetic analyses to determine the extent of variation within and between *Nasturtium gambelii* populations and the magnitude of the threat of gene swamping from *N. officinale* to help determine an appropriate recovery and reintroduction strategy.

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U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW of *Rorippa gambellii* [*Nasturtium gambelii*] (Gambel's watercress)

Current Classification: Endangered

Recommendation Resulting from the 5-Year Review:

____ Downlist to Threatened
____ Uplist to Endangered
____ Delist
__X__ No change needed

Review Conducted By: Mark A. Elvin

FIELD OFFICE APPROVAL:

Lead Field Supervisor, U.S. Fish and Wildlife Service

Approve _____ Date 10/27/11

REGIONAL OFFICE APPROVAL:

Assistant Regional Director, U.S. Fish and Wildlife Service, Region 8

Approve _____ Date 11/7/11