

Lithophragma maximum
(San Clemente Island Woodland Star)

**5-Year Review:
Summary and Evaluation**

**U. S. Fish and Wildlife Service
Carlsbad Fish and Wildlife Office
Carlsbad, California**

September 2007

5-YEAR REVIEW

Species reviewed: *Lithophragma maximum* (San Clemente Island Woodland Star)

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5-YEAR REVIEW
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I. GENERAL INFORMATION

I.A. Methodology used to complete the review: The Carlsbad Fish and Wildlife Office of the U.S. Fish and Wildlife Service (Service) initiated a 5-year review of the San Clemente Island Woodland Star (*Lithophragma maximum*) in July 2005. The Service solicited information from the public through two Federal Register notices (70 FR 39327 and 70 FR 66842). We considered office files, available literature, new survey information, and interviews of individuals involved with surveying, research, and management of this species.

I.B. Reviewers

Lead Region: Mary Grim, California-Nevada Operations Office, 916-414-6453

Lead Field Office: Karen Goebel and William B. Miller, Carlsbad Fish and Wildlife Office, 760-431-9440 ext. 206

I.C. Background

I.C.1. FR Notice citation announcing initiation of this review: On July 7, 2005, the U. S. Fish and Wildlife Service (Service) announced initiation of the 5-year review for *L. maximum* and asked for information from the public regarding the species' status (70 FR 39327). A second notice announcing the 5-year review and extending the request for information until January 3, 2006, was published on November 3, 2005 (70 FR 66842). No information was received.

I.C.2. Listing history

Original Listing

FR notice: 62 FR 42692

Date listed: The final rule was published on August 8, 1997, and became effective September 8, 1997

Entity listed: Species. *Lithophragma maximum* Bacigalupi

Classification: Endangered

I.C.3. Associated rulemakings: None.

I.C.4. Review History: No status reviews have been completed since the time of listing.

I.C.5. Species' Recovery Priority Number at start of review : In the 2005 Recovery Data Call for the Carlsbad Fish and Wildlife Office *L. maximum* was

assigned a recovery priority of “2,” meaning that this species has a high degree of threat but also a high potential for recovery.

I.C.6. Recovery Plan or Outline: To date, a recovery plan has not been prepared that is specific to the recovery of *L. maximum*.

II. REVIEW ANALYSIS

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

II.A.1. Is the species under review listed as a DPS? No. The Act defines species as including any subspecies of fish or wildlife or plants and any distinct population segment of any species of vertebrate wildlife. This definition limits listing as a DPS to only 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 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? No. No recovery plan exists for this species.

II.C. Updated Information and Current Species Status

II.C.1. Biology and Habitat: *Lithophragma maximum* is a member of the saxifrage family (Saxifragaceae) and flowers from April to June (California Native Plant Society 2001). It is a rhizomatous (bearing horizontal subterranean stems), perennial herb with basal leaves and two or three stout flowering stems from 40 to 60 centimeters (cm) (16-24 inches (in.)) high. Each flower bearing stem produces 20 or more white to pinkish, bisexual, campanulate (bell shaped) flowers, each about 1 cm (0.5 in.) in length (Bacigalupi 1963; Junak and Wilken 1998). The fruit is a 3-valved capsule with numerous seeds (Bacigalupi 1963). The leaves are palmately compound (with the blade divided into leaflets that radiate from a common point) and arise from the base on slender petioles 15 cm. (6 in.) long. *Lithophragma maximum* is the only species within its genus known to occur on San Clemente Island (U. S. Department of the Navy 2001).

Distribution

The collection location for the 1936 type specimen of *L. maximum* on San Clemente Island is unknown and was described as coming from “...the shady side of a single canyon on the East side, in moist rocks” (Collection by Nell Murbarger, April 1936, U.C. sheet no. 557653 from Bacigalupi 1963). Another collection made by Dr. P.A. Munz on April 9, 1923, in the canyon below Lemon Tank (No. 6697), and described as *Heuchera* in his field notes, may have been *L. maximum* (Ferguson and Beauchamp 1981). Unfortunately, this collection was

misplaced (Ferguson and Beauchamp 1981). Because no other *Heuchera* or *Lithophragma* have been found on the island, it is possible that this was a historic location for *L. maximum* (Ferguson and Beauchamp 1981). However, the credibility of Lemon Tank as a historical locality for this species remains in question (62 FR 42692).

Without further discoveries, *L. maximum* was thought to be extinct until two small populations were found in 1979 at the bottom of Bryce Canyon (*ca.* 9 plants) and at the bottom of Eagle Canyon (*ca.* 3 plants) on the southeastern side of San Clemente Island (Bacigalupi 1979; Ferguson and Beauchamp 1981). Since that time, a number of small populations have been discovered in precipitous canyons along the eastern escarpment of the island between Eagle Canyon and the south fork of Matriarch Canyon (M. Elvin *in litt.* 1996; Helenurm 1997; Junak & Wilken 1998; U. S. Department of the Navy, Southwest Division, 2001; Junak 2006; Consortium of California Herbaria- Smasch Accession Results, http://ucjeps.berkeley.edu/cgi_bin/get_consort.pl).

Eagle Canyon, the location of the northernmost occurrence, is about 8 kilometers (km) (5 miles (mi.)) south of the questionable 1923 collection from Lemon Tank canyon (See Figure 1). The current range extends about 5.25 km (3.25 mi) south from Eagle Canyon, where its distribution is dissected by a series of precipitous, sometimes branching, canyons. Relative to the military use of San Clemente Island, the entire range of *L. maximum* falls within the shore bombardment area (SHOBA), an area that covers about the southern 1/3rd of San Clemente Island and is designated for ship to shore bombing exercises and other military training activities (U.S. Department of the Navy, Southwest Division, 2001).

Because documented occurrences sometimes fall in close proximity to one another (e.g. less than 0.4 km./ ¼ mi.), different mapping techniques have been used to document occurrences, and occurrences are often comprised of just a few individuals, the spatial distribution of the species is best described by the canyons where occurrences are concentrated and where ecological processes are likely to operate in common. Thus, while around 17 occurrences appear to have been documented since the rediscovery of the species, there are just five canyon areas where plants are concentrated (See Figure 1). These include from north to south: Eagle Canyon; Bryce Canyon; several un-named, closely spaced, branching canyons north of Mosquito Cove; Mosquito Cove Canyon; and Matriarch Canyon.

The two northern canyons, Eagle Canyon and Bryce Canyon, and the southernmost canyon, Matriarch Canyon, support very small satellite populations of 20, 34 and 10 plants, respectively. A majority of the occurrences (9 of 17 occurrences) and 71 percent of documented individuals (454 of 641 individuals) are concentrated within several closely spaced and sometimes interconnected branching canyons north of Mosquito Cove. The fifth concentration of plants is comprised of two occurrences of around 60 and 65 plants each, which are found

less than 0.4 km (1/4 mile) apart in adjoining tributary forks of Mosquito Cove Canyon (Ferguson and Beauchamp 1981; M. Elvin *in litt.* 1996 ; Helenurm 1997; Junak & Wilken 1998; U. S. Department of the Navy, Southwest Division, 2001; Junak 2006)

In summary, *L. maximum* has an extremely restricted and dissected distribution with one major concentration of plants in the branched canyons north of Mosquito Cove Canyon, a small to moderate sized population in Mosquito Cove Canyon, and three very small peripheral populations in the canyons at the southern and northern limits of its range.

Abundance

As described above, *L. maximum* was presumed extinct until its rediscovery in 1979. At the time of listing in 1997, there were 11 known populations from the southeastern portion of San Clemente Island (62 FR 42692). Based on a recent compilation of records in Carlsbad Fish and Wildlife Office (CFWO) files, it appears that around 17 locations have now been documented for the species (Figure 1 and Appendix 1). However, this may not accurately represent the total number of extant occurrences since multiple records within the same canyon often reflect an accumulation of records made by independent observers using different mapping methods over a span of years. Thus, it is possible that two or more records in close proximity to one another within the same canyon could refer to the same population.

If one ignores the potential that more than one record could represent the same population and sums the most recent approximate count of individuals per occurrence measured since 1979, then about 641 individuals of *L. maximum* have been documented throughout its range. As discussed above, a majority of the occurrences (9 of 17 occurrences) and 71 percent of documented individuals (454 of 641 individuals) are concentrated within several closely spaced and sometimes interconnected branching canyons north of Mosquito Cove covering an area of 13.3 hectares (ha.) (32.9 acres (ac.)). The remaining occurrences and individuals are confined within four separate canyon areas that cumulatively support 20, 32, 125 and 10 individuals, respectively.

Overall, the number of individuals counted per occurrence is very small with just 6 of the 17 occurrences having been documented with over 50 individuals (Appendix 1). Counts have ranged from 2 to 104 individuals (median = 17, average = 30). Only two of the occurrences documented since the time of listing (Junak 2006) appreciably expand the range of the species. These include an observation of a small population of 7 plants towards the top of Bryce Canyon, and an occurrence of 10 plants in Matriarch Canyon (Junak 2006).

There is little information for judging population trends because surveys conducted over the last decade have focused on documenting new occurrences rather than monitoring the status of known occurrences (S. Junak pers. comm.

2006). Because there is no information to indicate that specific occurrences have been lost from activities on San Clemente Island, most occurrences discovered since 1979 are assumed to remain extant.

In contrast to a statement in the final rule that around 200 plants were located during Spring 1996 field surveys (62 FR 42692), CFWO files now suggest that around 365 plants were found in 1996. In either case, these totals represent a compilation of data from several independent survey efforts and neither should be viewed as a definitive single year population estimate (Appendix 1).

Demographically, when surveyors have noted the age of plants, they are often recorded as being of an adult/mature age class (Junak and Wilken 1998). However, young plants have also been observed indicating that plants grow from seed on occasion (Junak and Wilken 1998; S. Junak pers. comm. 2006). Seed has also been collected several times from populations of *L. maximum* (M. Elvin *in litt.* 1996; Helenurm 1998; Ferguson and Beauchamp 1981). Some of this seed is now banked at the Rancho Santa Ana Botanic Garden for conservation purposes (S. Jett pers. comm. 2006).

The best information regarding population dynamics is obtained from those populations that have been visited more than once. At a population in lower Eagle Canyon, two plants were observed in 1979, with no plants observed during the succeeding two years (Appendix 1). In upper Eagle Canyon, three visits to a population between 1980 and 1997 documented from 12 to 20 plants. Along the north fork of Mosquito Cove Canyon, 16 plants were recorded in 1991, and around 60 plants were recorded in 1996. At the two other occurrences where there is data for more than one year, population counts have remained fairly constant (Appendix 1). This suggests that numbers of *L. maximum* may remain relatively stable from year to year (*i.e.*, the species is not prone to dramatic population fluctuations).

In summary, although as many as six new records have been made for *L. maximum* since the time of listing, the overall number of individuals documented for this species remains low (~641) with a majority of occurrences (9 of 17) and 71 percent of documented individuals (454 of 641) concentrated within a relatively small area comprised of several closely spaced and sometimes interconnected branching canyons north of Mosquito Cove. The remaining occurrences are confined within four nearby but separate canyon areas that likely isolate and circumscribe small satellite populations of 20, 32, 125 and 10 individuals each. Two populations documented since the listing expand the known range of the species. However, only one of these populations falls within a canyon where *L. maximum* was previously unknown, and each is small and contributes little to the total number of plants known for the species.

Habitat

Lithophragma maximum is restricted to several steep canyons along the eastern escarpment towards the southern end of San Clemente Island. Plants are generally found in shady conditions on ledges on canyon walls and on gentle north-facing slopes in moist canyon bottoms between elevations of 120 to 366 meters (m) (400-1200 feet (ft.)) (Junak and Wilken 1998; Junak 2006; S. Junak pers. comm. 2006). Soils are usually at least vernal moist and are generally loams of varying depth that are derived from rock of volcanic origin (Ferguson and Beauchamp 1981; Junak pers. comm. 2006). A number of populations are found downslope from sizable groves of *Lyonothamnus floribundus* ssp. *aspleniifolius* (Santa Cruz Island ironwood), suggesting a possible association with this species (Junak and Wilken 1998; S. Junak pers. comm. 2006).

Although no quantitative estimate exists of the amount of such habitat on San Clemente Island, a geographic information system (GIS) exercise was conducted in 1994 to model potential habitat for *L. maximum*. That effort overlaid historic and current population sites with vegetation, soil, geology, landform, percent slope, and solar insolation information to predict suitable habitat. It suggested that suitable habitat could extend to most canyons along the southern two-thirds of the eastern side of San Clemente Island, a distance of about 45 km (28 mi.). This range is similar to what may have once been the historic distribution of island woodlands, which are thought to have covered much of the eastern escarpment prior to severe defoliation of the island by grazing and browsing mammals (Kellogg and Kellogg 1994). The modeling effort also suggested that some isolated pockets of suitable habitat could exist within a few canyons that drain toward the western side of the island (Kellogg and Kellogg 1994).

Based on observations of plants in “Near Death Canyon” in 1991, one surveyor suggested a narrower range for the species, with suitable habitat likely to occur in “...all of the major canyons between Eagle Canyon and Canchalagua Canyon...” along the eastern escarpment (Mistretta 1992). Plants are now known from most of the major canyons between Eagle Canyon and Matriarch Canyon, which is a slight extension of this range to the next canyon south of Canchalagua Canyon.

Defoliation from overgrazing by non-native mammalian herbivores has resulted in severe destruction and alteration of habitat on San Clemente Island that likely curtailed the range of this species. Even following removal of all of the feral and domestic mammalian herbivores from the island in 1992, excessive erosion due to the degraded condition of plant communities remains a threat to *L. maximum*. Soil loss in groves of oaks and ironwood trees associated with canyons along the eastern escarpment has led to root exposure and death of trees. Gullying and piping along plateau areas may be concentrating runoff to unnatural levels within the canyons below (Kellogg and Kellogg 1994).

Contemporaneous with, and likely aided by the presence of feral grazing animals, a large number of invasive alien species have naturalized on the island and

become a dominant component of many habitats. A 1992 flora compilation for San Clemente Island listed 380 species, 99 of which were exotic, 4 listed as endangered and 2 believed to be extinct (Kellogg and Kellogg 1994). Several exotic plant species have been found to co-occur with *L. maximum*, including *Bromus diandrus*, *Galium aparine*, *Silene gallica* and *Sonchus oleraceus* (Junak and Wilken 1998).

Another factor influencing plant communities at the southern portion of San Clemente Island are high fire frequencies associated with bombing exercises conducted by the military within SHOBA. Due to the potential for unexploded live ordinance to occur within this area, unless a fire threatens human life or facilities, it typically is allowed to burn itself out (U. S. Department of the Navy, Southwest Division 2001, L. Kellogg pers. comm. 2006). Most of the southern portion of the island within and adjoining SHOBA has burned at least once since 1979 (U. S. Department of the Navy, Southwest Division 2001). A map of fire boundaries between 1979 and 2004 further reveals a mosaic pattern of fire frequency, where some areas have burned multiple times and others have only burned once or a few times (U. S. Department of the Navy, Southwest Division 2001, Map 3-1).

Because of the elevated risk of fire associated with training activities in SHOBA, live and non-live munitions fire is targeted towards two delineated impact areas in the southwestern portion of the island where training disturbances and repeated fires are concentrated (U. S. Department of the Navy, Southwest Division 2001). These impact areas are west of and downslope from the canyons along the eastern escarpment where *L. maximum* is distributed. The location of *L. maximum* in canyon bottoms and on ledges in canyons along the eastern escarpment provides some protection from fires that escape the impact areas because these fires must crest a plateau and burn down-slope into the precipitous eastern canyons to get to *L. maximum*. However, fires frequently burn the plateau area above the eastern canyons and occasionally will extend into the eastern canyons. Thus, fire is an ongoing source of disturbance in *L. maximum* habitat that has potential to trigger exceptional erosion events (Wells 1987), facilitate the ongoing invasion by non-native plant species (D'Antonio and Vitousek 1992), and cause the direct loss of *L. maximum* plants and seeds.

Overall, there has been an improvement in the condition of the flora on San Clemente Island following feral animal removals (Tierra Data Inc. 2005). This has led to an increase in cover of both native and non-native species (E. Kellogg pers. comm. 2006; Tierra Data Inc. 2005). However, re-establishment of individual species has proceeded differentially, with some species regenerating readily and others showing little or no recruitment. Within Eagle Canyon, one of the locations for *L. maximum*, a number of native soft-wooded perennial species, including *Galvezia speciosa*, *Mimulus flemingii*, *Stephanomeria blairii*, *Castilleja grisea*, *Lotus dendroideus* var. *traskiae*, and *Galium catalinense*, appear to be readily regenerating and re-colonizing (O. Mistretta *in litt.* 1996). In contrast,

ironwood groves have stabilized with re-sprouts from basal burls, but there appears to be little or no recruitment of new individuals of this species (O. Mistretta *in litt.* 1996, Tierra Data Inc. 2005).

Similar to Santa Cruz Island ironwood, *L. maximum* appears to have had only a modest improvement in its status since feral animal removals, with the discovery of about nine new occurrences since animals were removed in 1992. While this represents about half of the known occurrences for the species, in absolute terms this is a small number relative to the level of recovery observed for other native plants on San Clemente Island (Tierra Data Inc. 2005). Additionally, a majority of these discoveries were made near previously known sites and could represent more accurate mapping of previously documented occurrences. This suggests that *L. maximum* may be naturally rare or that factors other than grazing by feral mammalian herbivores may continue to limit the distribution of this species.

In summary, *L. maximum* is generally found in moist, shady conditions on ledges on canyon walls and on gentle north-facing slopes in canyon bottoms along the eastern escarpment of San Clemente Island (Junak and Wilken 1998; Junak 2006; S. Junak pers. comm. 2006). A number of populations are found downslope from sizable groves of Santa Cruz Island ironwood, (Junak and Wilken 1998; S. Junak pers. comm. 2006), and habitat modeling suggests suitable habitat could coincide with what may have once been the historic distribution of island woodlands prior to severe defoliation of the island by introduced domestic and feral mammalian herbivores (Kellogg and Kellogg 1994). Removal of the last remaining feral animals in 1992 has led to an overall improvement in the condition of both the native and non-native flora in *L. maximum* habitat. However, the legacy of these animals remains in the form of lost soil, accelerated and concentrated erosion in the steep eastern canyons, and the facilitated invasion of *L. maximum* habitat by non-native plant species. Frequent fire on the plateau above the eastern canyons and occasional fire within those canyons also represents a source of ongoing disturbance that has potential to trigger exceptional erosion events, further facilitate the invasion by non-native plant species, and cause the direct loss of plants and seed.

Reproduction

Although the number of known occurrences of *L. maximum* has increased, there remains little information regarding its reproductive ecology. Most of what is known is inferred from studies of other species in the genus. White, sometimes scented flowers within *Lithophragma* suggest plants may rely on moths for pollination (Taylor 1965; Kellogg and Kellogg 1994). During three years of field work, one genus of moth (*Lampronia*) and four genera of bees (*Andrena*, *Apis*, *Osmia* and *Chloralictus*) were collected during a study of several species of *Lithophragma* (Taylor 1965). Exclusive visitation by one species of moth to *L. parviflorum*, in a community where other white-flowered plant species were present, suggested the possibility of pollinator host specificity (Taylor 1965). Thus, of the pollinators collected on the genus, moths were thought to represent

the most important single class of pollinators (Taylor 1965). Based on the apparent scarcity of insect pollinators found on other *Lithophragma*, it has been suggested that a lack of pollinators on San Clemente Island could be impairing successful sexual reproduction of *L. maximum* (Kellogg and Kellogg 1994).

Based on its growth habit and knowledge of vegetative reproduction in other *Lithophragma*, *L. maximum* is likely capable of vegetative reproduction via rhizomes and bulblets (Bacigalupi 1963; Taylor 1965; U. S. Department of the Navy 2001). Studies to characterize sexual reproduction in the genus found that of seven species studied (including two subspecies of one species, for a total of eight taxa), four were entirely self-incompatible and the remaining species were partially so, with just 12-50 percent seed set resulting from self-pollination (Taylor 1965). Random crosses between members of the same population within a species were also unsuccessful for two species (*L. affine* and *L. heterophyllum*), suggesting that individuals in these populations possessed the same self-incompatibility alleles (Taylor 1965). This contrasts with over 90 percent successful crosses among individuals from different populations and suggests that populations of these species may sometimes be derived from one or a few plants that propagate via efficient vegetative reproduction (Taylor 1965). Evidence that a self-incompatibility system operates within the genus suggests that *L. maximum* may also be partially or completely self-incompatible (Taylor 1965; Junak and Wilken 1998).

Attempts to grow plants from seed have met with mixed, but usually poor, success (Helenurm 1998; Ferguson and Beauchamp 1981). Taylor (1965) reports that a controlling environmental factor for germination of a number of species in the genus is temperature, with optimal germination being found at temperatures that most closely approximate those in their natural environment. Ferguson and Beauchamp (1981) reported that no successful germination was achieved at Rancho Santa Ana Botanic Garden or Pacific Southwest Nursery from *L. maximum* seed that was collected during 1979 and 1980. Helenurm (1998) found seed germination and seedling survival rates under greenhouse conditions to be very low. He was able to improve seed germination by scarification and treatment with gibberellic acid, but seedling survival remained "...low due to the small size of seedlings and their susceptibility to pathogens" (Helenurm 1998). A 1998 effort at the Rancho Santa Ana Botanic Gardens to grow plants from seed obtained about 3 percent germination success, resulting in the propagation of 6 plants from 350 seeds (C. Ames pers. comm. 2006). Secondary collections of seed from those plants now contribute to the seed bank for this species (S. Jett pers. comm. 2006). A more recent effort to germinate seeds at the same location in 2006 was unsuccessful (C. Ames pers. comm. 2006).

Genetics

Starch gel electrophoresis was used by Helenurm (1997) to study variation in the expression of genes coding for specific cellular enzymes known as "allozymes" (primary gene products) within *L. maximum*. Genotypes at 24 loci were scored

for 107 individuals from five populations. Only a single allele was detected at each locus scored, revealing there was no detectable genetic variation either within or among populations using this technique. Because all populations share alleles at the same frequencies, these results provide no way of inferring patterns of gene flow, discerning evolutionary processes, or distinguishing relationships among populations, such as whether populations in proximity are more closely related than those separated by a greater distance (Helenurm 1997).

Although these results should not be interpreted as evidence of no genetic variation in the species because genetic variation may be detectable using another technique, the lack of variation among the large number of loci studied (24) indicates that genetic variation in *L. maximum* is unusually low (Helenurm 1997). This may be associated with its narrow geographic distribution and possibly its recent evolutionary origin (Helenurm 1997). Overall, the absence of observed genetic variation suggests that *L. maximum* may be especially vulnerable to inbreeding depression (i.e. loss of fitness associated with the mating of closely related individuals) and to low short-term and long-term fitness associated with homozygosity (e.g. an inability to adapt to a changing environment due to a lack of available genetic variation) (Helenurm 1997).

Taxonomy

No taxonomic classifications or changes in nomenclature have been published since the listing in 1997.

II.C.2. Five-Factor Analysis (threats, conservation measures, and regulatory mechanisms)

The factors affecting *L. maximum* discussed in the final rule (62 FR 42692) included loss of habitat from erosion induced or exacerbated by herbivore damage, the presence of invasive exotic plant species, and fires induced by military activities. These factors continue to represent the primary threats to the habitat and range of the species. Another recently recognized factor that may represent a potential threat to recovery is restricted access imposed by the military to populations of *L. maximum* that could interfere with effective management of the species.

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

Erosion

The decline of *L. maximum* and the decline of all of San Clemente's endemic flora is primarily attributed to the introduction of non-native animal and plant species by Euro-Americans during the last 200 years (62 FR 42692). Goats (*Capra hircus*) were present on San Clemente Island as early as 1827 (Dunkle 1950), and sheep (*Ovis aries*) were introduced around 1868 (Kellogg and Kellogg

1994). Other large-stature herbivores historically introduced to San Clemente Island included cattle (*Bos taurus*), pigs (*Sus scrofa*), and mule deer (*Odocoileus hemionus*) (62 FR 42692).

In particular, ranching of sheep and, following their removal, proliferation of goats led to severe overgrazing, trampling of vegetation, and denudation of the island (O'Malley 1994; Dunkle 1950). With intensive grazing pressure leading to near complete consumption of grasses, sheep and goats fed on less palatable shrubs and trees causing a tremendous loss of shrub and tree cover (Kellogg & Kellogg 1994; O'Malley 1994). Creation of bare trails and denuded areas led to severe erosion causing the stripping of vegetation and soil. Accelerated erosion was likely exacerbated by reduction in vegetation cover associated with periods of drought and fire (Johnson 1980). Loss of soil within island woodlands along the eastern escarpment where *L. maximum* occurs has led to much root exposure and subsequent death of trees (Kellogg and Kellogg 1994).

In an effort to preserve the remaining San Clemente Island endemic flora and fauna, all feral goats and pigs were removed from the island by the Navy in 1992 prior to the listing of *L. maximum* (Kellogg and Kellogg 1994). This has diminished the threat of erosion to *L. maximum* (S. Junak pers. comm. 2006). However, the threat from erosion persists due to remaining gullying and piping along plateau areas above canyons occupied by *L. maximum*, which may be concentrating runoff to unnatural levels within the canyons below (Kellogg and Kellogg 1994). Possibly the most significant remaining threat from this factor is exceptional erosion events (U. S. Department of the Navy 2001), such as would be anticipated to accompany a fire that burns habitat above the species (Wells 1987). Military training exercises in SHOBA have led to a pattern of recurrent fire on the plateau above the eastern facing canyons where *L. maximum* occurs, with fire occasionally extending into these canyons (U. S. Department of the Navy, Southwest Division 2001, Map 3-1, p 3-5).

Non-natives

Another threat to *L. maximum* is the spread of invasive non-native plants into its habitat. Exotic species have potential to compete with *L. maximum* for space or other resources such as light, water, and nutrients. Exotic invasives can also alter habitat structure, ecological processes such as nutrient cycling (Zink *et al.* 1995), and the prevalence of fire (Brooks 1999).

By 1992, 99 exotic species were documented as occurring on San Clemente Island (Kellogg and Kellogg 1994), with many of them having become naturalized and a significant component of island habitats. Since then, new exotics continue to be discovered, which may represent new introductions from military personnel, vehicles, and/or equipment (*e.g.*, *Schismus* sp., *Brassicae tournefortii*) (J. Dunn pers. comm. 2006; E. Kellogg pers. comm. 2006; S. Junak pers. comm. 2006).

Although no single invasive non-native plant species has been identified as posing a specific competitive threat to this species, invasive annual grasses may pose the biggest threat over the long term (S. Junak pers. comm. 2006) due to their ability to rapidly colonize and exploit many different microhabitats. Ripgut grass (*Bromus diandrus*) is one of several exotic plant species that have been found to co-occur with *L. maximum* (Junak and Wilken 1998).

Through exploitation of a broad range of conditions, grasses can create a continuous and persistent fuel bed by filling in what was once plant-free space with living plants and thatch (Brooks 1999). Because annual grasses vary in density with rainfall they also have potential to significantly alter the fuel condition in wet years. Invasion and proliferation of non-native annual grasses in the genera *Bromus* and *Schismus* in the Mojave Desert has been implicated as a major factor responsible for reduced fire intervals and increased fire intensity in that formerly sparsely vegetated biome (Brooks 1999; U. S. Geological Service Website <http://www.werc.usgs.gov/invasivespecies/mojavegrassfire.html>). Type conversion of native shrublands to alien dominated grasslands following fire has also been commonly observed (Keeley *et al.* 2005). Thus, invasion of *L. maximum* habitat by invasive exotic plant species, including non-native annual grasses in particular, has potential to result in direct competitive displacement of plants and/or to indirectly alter habitat suitability through influences on habitat structure and the prevalence of fire.

Military Activities and Fire

San Clemente is owned by the U. S. Department of the Navy. With its associated offshore range complex, it is the primary maritime training area for the Navy Pacific Fleet Navy Sea, Air, and Land (SEALS), and it supports training by the U. S. Marine Corps, the U. S. Air Force, and others. As the last range in the eastern Pacific Basin where many training operations are performed prior to troop deployments, portions of the island receive intensive use. Associated with training operations is an elevated risk of fire (e.g. 117 wildfires that burned 10,645 ha/26,304ac.were recorded on San Clemente Island between 1990 and 2001: U. S. Department of the Navy 2001).

The distribution of *L. maximum* occurs entirely within the Shore Bombardment Area (SHOBA) on San Clemente Island. SHOBA encompasses approximately the southern one-third of the island and supports a variety of training operations involving both live and non-live munitions fire (U. S. Department of the Navy 2001). These operations include: Naval Surface Fire Support (NSFS), which involves live fire from ships to impact areas; Combined Arms exercises, which involves practicing coordination of all supporting arms of the Navy, Marine Corps, and Air Force such as NSFS, Artillery, Mortars, Fixed Wing Aircraft, and Helicopters; Amphibious training of Marine Corps Artillery Units using live fire; close air support/strike using both live and inert munitions from fixed wing aircraft and helicopters; targeting precision-guided munitions with lasers; explosive ordinance disposal; and Naval Special Warfare operations. Certain

munitions exercises within SHOBA involve the use of incendiary devices, such as illumination rounds, white phosphorous, and tracer rounds, which pose a high risk of fire ignition (U. S. Fish and Wildlife Service 2002). Also within SHOBA, a northwesterly running ridgeline and associated plateau above the canyons along the eastern escarpment is identified as an area for infantry operations. Ridge Road follows this ridgeline and is the primary route to transport troops during supporting arms coordination exercises and fire support coordination exercises (U. S. Department of the Navy, Southwest Division 2001).

Because of the elevated risk of fire associated with training activities, live and non-live munitions fire is targeted towards two delineated impact areas in the southwestern portion of SHOBA where training disturbances and repeated fires are concentrated. Strip burning and fire retardant are used to maintain fuel breaks around these impact areas and to limit the spread of fires. However, fires also occasionally originate away from the impact areas, such as from training activities along Ridge Road (U. S. Department of the Navy 2001, Map 3-1).

To minimize the risk of fires spreading from the impact areas, the Navy has adopted a set of fire management policies and practices that include restricting the times and conditions when certain munitions can be used during the fire season, and making sure a fire-fighting helicopter is on the island during periods of military training within SHOBA (U. S. Fish and Wildlife Service 1997, 2002). However, because of the risk of explosion from unexploded ordinance, it is not safe to implement certain measures to combat fires that escape the impact areas, including using conventional ground attack or using helicopters from any altitude to make water drops. This results in occasional escape of fires from the impact areas and their spread into adjoining areas (Map 3-1, U. S. Department of the Navy 2001).

Due to the risks associated with fighting fires in SHOBA, fires are often allowed to burn themselves out and sometimes can burn for days, covering vast acreages (U. S. Department of the Navy 2001; E. Kellogg pers. comm. 2006). A comparison of San Clemente Island wildfires within SHOBA and outside of SHOBA between 1996 and 2004 reveals that while only 59 percent (54 of 91) of ignitions were initiated in SHOBA, 88 percent of the total burned land area (6242 of 7085 acres) was concentrated in SHOBA during this period.

The location of occurrences of *L. maximum* in canyon bottoms and on ledges in canyons along the eastern escarpment provides some protection from fires that escape the impact areas to the west because these fires must crest a plateau and burn downslope into the precipitous eastern canyons to get to *L. maximum*. However, fires sometimes ignite outside the impact areas and frequently burn the plateau area above the eastern canyons, occasionally extending into these canyons (Map 3-1, U. S. Department of the Navy 2001). Due to the steepness of the canyons along the eastern escarpment, any fire ignited below *L. maximum* will likely be rapidly drawn upwards and intensified by a chimney effect, imperiling

all that lies above. While the adaptedness of *L. maximum* to fire is unknown, any loss of plants from fire prior to their setting seed would be a threat to the small populations of this species.

Finally, *L. maximum*'s occurrence in moist areas raises the question of whether fire has been an important evolutionary force that has shaped the surrounding plant community and led to adaptations in this species. Following a 1999 fire in Canchalagua Canyon, four years of post fire monitoring of a stand of Santa Cruz ironwood, a species commonly associated with *L. maximum*, has shown a loss of trees and a decline in that stand, with no evidence of regeneration following the fire (Tierra Data Inc. 2005). Thus, no specific adaptations to fire are evident in this associated species. This suggests fire could be similarly problematic for *L. maximum*.

In summary, *L. maximum* habitat continues to be threatened with destruction from accelerated and concentrated erosion which persists as a legacy from almost two hundred years of over-grazing by introduced large stature mammalian herbivores. *Lithophragma maximum* habitat also continues to be modified through the ongoing invasion of non-native plant species, with non-native annual grasses posing a particular threat due to their ability to rapidly colonize disturbed areas and alter habitat structure. These factors may also operate synergistically with fire induced by military training within SHOBA, which has potential to trigger exceptional erosion events (Wells 1987), facilitate the invasion of *L. maximum* habitat by non-native plant species (D'Antonio and Vitousek 1992), and cause the direct loss of *L. maximum* plants and seeds.

II.C.2.b. Overutilization for commercial, recreational, scientific, or educational purposes: This factor was not determined to be applicable in the final rule (62 FR 42692). As a military installation, public access to San Clemente Island is restricted by the Navy. Known collections of this species since its listing have been performed primarily to promote the recovery of the species. The Rancho Santa Ana Botanic Garden currently maintains a bank of seeds for conservation purposes (C. Ames pers. comm. 2006).

II.C.2.c. Disease or predation: Based on the removal of the last remaining feral goats and pigs from San Clemente Island in 1992, and a lack of specific information regarding the potential for disease to affect *L. maximum*, this factor was not addressed as being applicable at the time of listing (62 FR 42692). Presently, there remain no known predators or diseases on San Clemente Island that pose a threat to the continued existence of this species. However, allozyme analysis has been unable to detect any measurable genetic variation within or among populations of *L. maximum* (Helenurm 1997). This suggests the species could be particularly vulnerable to disease should one arise because genetic variability will likely be needed to adapt to its presence.

II.C.2.d. Inadequacy of existing regulatory mechanisms: The final rule (62

FR 42692) addressed three plant species known from the California Channel Islands, including two taxa that were known from Santa Catalina Island, an area under California State jurisdiction. Therefore, the final rule analysis of regulatory factors affording protection to these species included a generalized discussion of regulatory factors applicable to land under both State and Federal jurisdiction. However, because *L. maximum* is known solely from San Clemente Island, an area under Federal jurisdiction, two of the four factors listed provide limited protection to *L. maximum*. These factors include: (1) State and local laws, regulations, and ordinances, including listing under the Native Plant Protection Act (NPPA) and the California Endangered Species Act (CESA); and (2) the California Environmental Quality Act (CEQA). The remaining two factors discussed in the final rule, the National Environmental Policy Act (NEPA), and the Endangered Species Act in those cases where *L. maximum* co-occurs with other listed species, remain applicable. Since the listing, pursuant to the Sikes Act Improvement Act of 1997, the Navy adopted an Integrated Natural Resource Management Plan (INRMP) for San Clemente Island (U. S. Department of the Navy 2001). While this is technically not a regulatory mechanism, it could provide some additional protection to *L. maximum* that was not previously considered. The following describes how each of these factors applies to the protection of *L. maximum*.

State and local laws, regulations and ordinances, including listing under the Native Plant Protection Act (NPPA) and the California Endangered Species Act (CESA): The California Fish and Game Commission has listed *L. maximum* as endangered under the NPPA (Division 2, chapter 10, section 1900 *et seq.* of the California Fish and Game Code (CFG)) and CESA (Division 3, chapter 1.5, section 2050 *et seq.* of the CFG). Both the NPPA and CESA include prohibitions forbidding the “take” of *L. maximum* (Chapter 10, Section 1908 and Chapter 1.5, Section 2080, CFG code). However, the NPPA, which is referenced as an exception to the “take” prohibitions of CESA, exempts a number of activities from regulation under the NPPA including: clearing of land for agricultural practices or fire control measures; removal of endangered or rare plants when done in association with an approved timber harvesting plan, or mining work performed pursuant to Federal or State mining laws, or by a public utility providing service to the public; and/or when a landowner proceeds with changing the use on their land in a manner that could result in “take,” provided the landowner notifies the California Department of Fish and Game at least 10 days in advance of the change. These exemptions indicate that CESA and NPPA may be inadequate to protect against the taking of *L. maximum* associated with a range of activities. Furthermore, although the California State Constitution calls for the enforcement of State laws on Federal land unless an appellate court has ruled to the contrary, the Federal government has supremacy when it comes to enforcement, so the Federal government is more or less immune to the provisions of NPPA and CESA on San Clemente Island (M. Showers pers. comm. 2006). In practice, listing under NPPA and CESA may only meaningfully protect *L. maximum* in those instances when a private project is proposed on San Clemente

Island or when proposed activities fall under other State laws (e.g., timber harvest or mining activities).

CEQA: The CEQA (California Public Resources Code (CPRC), section 21000 *et seq.*) requires that the potential environmental impacts of proposed projects be disclosed to the public and that significant environmental impacts (such as a reduction in the number or range of a rare or endangered plant or animal) be mitigated or allowed subject to a determination that “overriding social and economic considerations” make mitigation infeasible (CPRC, Guidelines, section 15093). However, CEQA does not apply to land under Federal jurisdiction. Therefore, CEQA affords no protection to *L. maximum*.

NEPA: Analogous to CEQA on land under State jurisdiction, NEPA requires the disclosure of the environmental effects of projects under Federal jurisdiction. Since *L. maximum* occurs on San Clemente Island, which is federally owned, NEPA governs activities with potential to impact this species. NEPA requires Federal agencies to integrate environmental values into their decision-making processes by considering the environmental impacts of their proposed actions and reasonable alternatives to those actions.

Co-occurrence with other federally listed species: The Endangered Species Act requires all Federal action agencies to insure that any action authorized, funded, or carried out by such agency is not likely to jeopardize the continued existence of any endangered or threatened species. Other listed species on San Clemente Island include: San Clemente loggerhead shrike (*Lanius ludovicianus mearnsi*), San Clemente Island sage sparrow (*Amphispiza belli clementine*), island night lizard (*Klauberina riversiana*), San Clemente Broom (*Lotus dendroideus* var. *traskiae*), San Clemente Island larkspur (*Delphinium variegatum* ssp. *kinkiense*), San Clemente Island indian paintbrush (*Castilleja grisea*), San Clemente Island bush mallow (*Malacothamnus clementinus*), and Santa Cruz Island rockcress (*Sibara filifolia*). In those cases where *L. maximum* occurs in habitat occupied by those species, some regulatory protection could be afforded to *L. maximum* through the obligation of the Navy to consult with the Service regarding any anticipated adverse impacts they may have to those species. Through the consultation process the Service often works with the Navy to identify measures that will avoid, minimize, and promote the conservation of listed species. *Lithophragma maximum* can thus benefit from the consultation process to the extent that avoidance, minimization, and conservation measures for other listed species similarly benefit *L. maximum*'s distribution.

Lithophragma maximum occasionally occurs with *Castilleja grisea* and occasionally occurs with or in proximity to *Lotus dendroideus* var. *traskiae* (U. S. Department of the Navy 2001). It also occurs in proximity to a proposed release site for San Clemente loggerhead shrike (U. S. Department of the Navy 2001). However, *L. maximum* does not consistently coincide with these species so

protection afforded them from the Endangered Species Act does not always extend to *L. maximum*.

The Navy has had numerous consultations with the Service regarding the effects of their activities on San Clemente Island on the above listed species. Most notable for *L. maximum*, the Navy has consulted on the effects of their fire management practices on San Clemente Island (U. S. Fish and Wildlife Service 1997, 2002). This consultation resulted in the establishment of practices that help to minimize the risk of spread of fire from training activities into areas supporting *L. maximum*. While these measures reduce the chance of wildfire, they do not eliminate this threat.

In sum, while *L. maximum* may occasionally benefit from its co-occurrence with, and consultations regarding, other federally listed species on San Clemente Island, protection under the Endangered Species Act may not be consistent or widespread for *L. maximum* in the absence of its listed status.

INRMP: In addition to conducting consultations on their activities, the Navy recently adopted an INRMP for San Clemente Island. An INRMP is a plan that is intended "...to guide installation commanders in managing their natural resources in a manner that is consistent with the sustainability of those resources while ensuring continued support of the military mission" (p. 1-1, U. S. Department of the Navy 2001). To achieve this, the San Clemente Island INRMP proposes an array of management strategies to address identified goals and objectives for specified management units and their natural resources.

Although an INRMP may involve adaptation of policies, it technically is not a regulatory mechanism because its implementation is subject to funding availability (U. S. Department of the Navy 2001). However, the Navy does implement the recommendations of the INRMP that fall within the framework of existing regulatory compliance (*e.g.*, terms and conditions of existing consultations with the Service) (U. S. Department of the Navy 2001). Funding allocations and implementation of other tasks identified in the INRMP are based on identified programming and budgeting priorities for conservation programs, with priority given to mission obligations, requirements derived from existing laws and regulations, and objectives for federally listed species and their habitats (U. S. Department of the Navy 2001).

Of relevance to the protection of *L. maximum*, the San Clemente Island INRMP includes an objective to: "Protect, monitor, and restore plants and cryptograms in order to manage for their long-term sustainability on the island" (p. 4-39, U. S. Department of the Navy 2001). Associated with this objective are a number of proposed management strategies that include: consideration of *L. maximum* as a "management focus plant" such that it is considered independently from its associated plant community for management; conducting status surveys for this species; ensuring that management focus plants have a network of suitable sites;

performing pollination studies on *L. maximum*; and continuing to apply genetic research and management approaches to its management. Other management measures that are identified in the INRMP specifically for management units where *L. maximum* is known to occur (Units 11, 14, and 18) include: managing fire encroachment risk from the west; managing fire size, intervals, and intensity within the management units; and managing invasive species, especially black mustard (*Brassica nigra*), along Ridge Road.

Possibly in conflict with protection and/or recovery of *L. maximum* is the competing objective included in the INRMP to protect military access to SHOBA firing ranges to the west of *L. maximum* occurrences due to SHOBA's high military value for ship-to-shore bombardment training (U. S. Department of the Navy 2001). To minimize this conflict, the INRMP includes a set of Fire Management Guiding Principles that derive in part from the Navy's consultation with the Service on their fire management practices (U. S. Fish and Wildlife Service 1997, 2002). The INRMP also references a Fire Management Plan that has yet to be proposed or adopted (L. Kellogg, pers. comm. 2006). Presently, the guiding principles emphasize the allocation of fire protection resources for human life and firefighter safety first, with high-value vulnerable facilities, structures, habitats, and natural and cultural resources ranked second. The guiding principles call for the use of pre-suppression management to reduce the risk of ignitions and adverse ecological effects of wildland fire. When pre-suppression management strategies are needed to protect natural resource assets, highest priority is given to those assets that fall under regulatory compliance (*e.g.*, listed species).

To date, a number of the INRMP management strategies have been implemented. The Navy has implemented rare plant surveys that have documented new occurrences of *L. maximum*. Genetic research on *L. maximum* has also been performed. Concerted efforts have been made to control escape of fire from the SHOBA Impact Areas. However, other objectives have not been achieved, such as pollination studies or applying genetic research to management of the species.

In conclusion, the listing of 8 other species on San Clemente Island has conferred some protection from the Federal Endangered Species Act ("Act") to *L. maximum* in those cases where it co-occurs with those species, but this protection is not consistent or widespread. Similarly, by helping to integrate the military's mission with natural resource protection on San Clemente Island, the INRMP appears to improve the protection of *L. maximum* by targeting a number of management objectives towards protection of *L. maximum* and its habitat. However, the prioritization of funding for INRMP objectives, and the competing INRMP objective of protecting military access to SHOBA firing ranges, suggests that conservation of *L. maximum* by the INRMP is only assured to the extent that it falls within the framework of other regulatory compliance. Thus, the protections afforded by the ESA and INRMP improve the status of but do not assure the conservation of *L. maximum*.

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

There are several natural factors in addition to the systematic factors discussed above (*e.g.*, habitat loss due to erosion) with potential to affect the continued existence of *L. maximum*. Because *L. maximum* is an insular endemic species that is narrowly distributed within only five canyons on San Clemente Island, the species is vulnerable to a number of stochastic factors such as demographic stochasticity, environmental stochasticity, genetic stochasticity, and natural catastrophes (Shaffer 1981). Additionally, because San Clemente Island is a military installation, one man-made factor that may limit its recovery is constrained access to its habitat for implementing active management and erosion control measures.

Stochastic Factors

Demographic stochasticity arises from variability in probabilities (rates) of survival or reproduction among individuals within a population (Lande 1988). Assuming these rates vary independently among individuals, sampling variance in vital rates can play a large role in the extirpation of finite populations, such as are found for *L. maximum*.

Environmental stochasticity arises from temporal variation in habitat parameters or populations of competitors, predators, parasites, and disease (Shaffer 1981). These factors commonly affect vital rates independently of population size and can affect all individuals similarly. Because most populations undergo fluctuations due to weather or abundances of interacting species, changes to vital rates from these factors can result in extinction rates greater than would be predicted by sampling variance in vital rates alone (Lande 1988). It has been suggested that *L. maximum* could already suffer from low pollinator services and impaired sexual reproduction due to the potential for the historically severe habitat alterations on San Clemente Island to have impacted what was likely an already scarce pollinator community (Kellogg and Kellogg 1994; Taylor 1965).

Genetic stochasticity results from changes in gene frequencies due to founder effects, random fixation (*e.g.*, genetic drift) or inbreeding (Shaffer 1981). So far, allozyme analysis has been unable to detect any genetic variability within or among populations of this species, which could provide an indication that populations are already inbred or otherwise comprised of clonal plants (Helenurm 1997). Because not much is known about the mating system for *L. maximum*, it is unknown whether inbreeding of populations has or could lead to inbreeding depression (*i.e.*, loss of reproductive fitness or vigor). However, the absence of detectable genetic variation suggests that *L. maximum* may be especially vulnerable to inbreeding depression and to low short-term and long-term fitness associated with homozygosity (Helenurm 1997). There is also evidence that a self-incompatibility mechanism operates within other species within the genus, suggesting that *L. maximum* could also rely upon outcrossing for successful sexual reproduction (Taylor 1965; Junak and Wilken 1998). It is possible that low seed germination success and/or the low survivorship of seedlings that has

been obtained during efforts to propagate the species (Ferguson and Beauchamp 1981; Helenurm 1998; C. Ames pers. comm. 2006) are manifestations of inbreeding depression. If *L. maximum* has a self-incompatibility mechanism, the small size of populations and absence of detectable genetic variability could provide an indication that populations already have impaired reproductive capability due to shared self-incompatibility alleles among closely related individuals (Helenurm 1997).

Finally, given the extremely restricted distribution of this species, any natural catastrophe, such as a fire, landslide, or prolonged drought, could lead to the extirpation of the species. All of the known occurrences of *L. maximum* are within SHOBA along the southeastern side of San Clemente Island within a range of about 5.25 km (3.25 miles). Given the pattern of frequent and sometimes extensive fires in SHOBA (U. S. Department of the Navy 2001), one or more fires that occur in close succession could burn the entire range of the species.

A factor that may help to diminish the risk of extinction of *L. maximum* is the conservation banking of seeds at the Rancho Santa Ana Botanic Garden (C. Ames pers. comm. 2006). While seed banking, in itself, does nothing to ameliorate the systematic or stochastic threats facing natural populations, it does provide source material to re-establish populations in the wild should they become extirpated. Still, poor germination success and low survivorship of seedlings of *L. maximum* (Ferguson and Beauchamp 1981; Helenurm 1998; C. Ames pers. comm. 2006) suggests that this may be an unreliable means for ensuring the survival of this species.

Access to SHOBA

Because SHOBA is used for ship-to-shore bombardment, as well as other munitions training exercises, access to this area is often restricted for non-military personnel. These restrictions can influence both the timing and locations where access is granted.

Historically, biologists doing surveys, and other individuals doing invasive species control, have been granted access to SHOBA during times that do not conflict with military exercises. Because sensitive resources are known to occur within the impact areas, biologists have also generally been granted access to the impact areas. However, because of the frequency of training, access to SHOBA can be restricted for several weeks at a time or longer, and there may only be brief intervals when biological work can be done (K. O'Connor pers. comm. 2006). This access limitation and the lead time needed for range scheduling can undermine the effectiveness of surveys and invasive species control efforts by limiting the ability to time these activities during optimal times in the life cycle of target organisms (*e.g.*, spraying herbicide prior to an invasive plant setting seed).

Safety concerns relative to the presence of unexploded ordinance within SHOBA have recently prompted the Navy to re-assess access policies (K. O'Connor pers.

comm. 2006). During the winter and spring of 2006, all access for non-military personnel within SHOBA was withheld for a 1 to 2-month period, and the Navy is now considering adopting a new set of policies to address access (K. O'Connor pers. comm. 2006). These policies are anticipated to restrict access to the impact areas during times when an explosive ordinance device escort can be present, but this could eliminate all access to the Impact Areas by biologists and restoration personnel (K. O'Connor pers. comm. 2006). Because the entire distribution of *L. maximum* falls within SHOBA, existing access restrictions along with those proposed could impair the ability of biologists to effectively study and manage the species.

Due to a brief flowering season, pollination and out-crossing studies necessarily must be conducted opportunistically during the spring. Ongoing monitoring and treatment may also be needed to detect and combat new invasive exotic plants prior to their becoming established and presenting a significant threat to this species. As discussed above, invasive species are one of the primary threats to *L. maximum* due to their potential to directly compete with individual plants for light and space and/or their ability to indirectly increase the frequency and intensity of fire within its habitat.

In summary, even in the absence of threats from erosion, non-native plant species and military activities, the extremely restricted distribution and small size of populations of *L. maximum*, makes this species vulnerable to extinction from a number of stochastic factors alone. Restricted access by the military to its habitat may also impair the recovery of *L. maximum* by interfering with the timing and ability to perform active management to ameliorate systematic and stochastic threats.

II.D. Synthesis - The decline of San Clemente Island's endemic flora and fauna is primarily due to the introduction of non-native animal and plant species by Euro-Americans during the last 200 years (62 FR 42692). Defoliation from overgrazing by non-native mammalian herbivores, in particular, resulted in severe habitat destruction and alteration that likely facilitated the invasion and proliferation of exotic plant species within many habitats.

In an effort to preserve the remaining San Clemente Island endemic species, the Navy removed the last of the remaining feral goats and pigs from the island in 1992, five years prior to the listing of *L. maximum* (Kellogg and Kellogg 1994; 62 FR 42692). This has led to considerable improvement in the condition of the flora on San Clemente Island, and several other listed plant taxa have appreciably increased in number and extent since feral animal removals (Tierra Data Inc. 2005).

However, there have just been modest gains in the number of known populations of *L. maximum*, with the discovery of about six new occurrences since the listing. Most of these new occurrences fall within areas where the species was previously known, and

could represent more accurate mapping of one or more of the prior records. Only one of the newly documented populations falls within a canyon where *L. maximum* was previously unknown, and it is comprised of just 10 individuals. Overall, *L. maximum* continues to have an extremely restricted and dissected distribution, with just one major concentration of plants in the closely adjoining branched canyons north of Mosquito Cove Canyon, a small to moderate sized population in Mosquito Cove Canyon, and three very small peripheral populations in the canyons at the southern and northern limits of its range.

Since the removal of feral goats and pigs should greatly improve its prospects for recovery, it is not clear whether the current distribution of *L. maximum* reflects the historic distribution for the species, or if it has failed to exhibit a more dramatic expansion in range or numbers due to ongoing systematic threats (*e.g.*, erosion, competition with exotic plant species, recurrent fire), a lack of pollinators, seed dispersal mechanisms, and/or other factors associated with small population size, low genetic variability, and its mating system. Nevertheless, the continuing low numbers and restricted distribution of the species indicates that it remains imperiled by some or all of these factors.

The confinement of occurrences to canyon areas further suggests that a single catastrophic event, such as a fire ignited from below, could cause the extirpation of all occurrences within a given drainage. This indicates that *L. maximum* remains in danger of extinction throughout all or a significant portion of its range and no change to its status is warranted at this time.

III. RESULTS

III.A. Recommended Classification: No change is needed.

III.B. New Recovery Priority Number: No change to the recovery priority is proposed at this time. *Lithophragma maximum* continues to face a high degree of threat but also continues to have a high recovery potential. Recovery Priority No. 2 remains appropriate for the species.

IV. RECOMMENDATIONS FOR FUTURE ACTIONS

Because no recovery plan for *L. maximum* exists, a primary recommendation is to prepare such a plan. However, a number of actions can proceed in the interim that will promote recovery. These actions include the following:

- (1) Study the reproductive ecology and mating system of *L. maximum* to determine whether populations suffer from low pollinator visitation and/or have a self-incompatibility mechanism (*e.g.* have genes that preclude mating among closely related individuals) that limits sexual reproduction in the species.

- (2) Perform additional genetic studies on *L. maximum* using randomly amplified polymorphic DNA (RAPDs) or other appropriate genetic markers to see if there is any detectable genetic variation in the species that will allow for inferences about relatedness of adjoining individuals, trends in genetic variation, patterns of gene flow, or other evolutionary processes.
- (3) Use existing or new seed collections to propagate and establish additional populations of *L. maximum* in appropriate habitat to help safeguard the species. Results from the prior two recommended actions should be used to select seed from the most genetically diverse source populations and to determine if transplantation into existing populations should be used to improve seed production and fitness of populations.
- (4) Work with the military to adopt a set of access policies for the shore bombardment area on San Clemente Island to facilitate effective management and monitoring of *L. maximum*. These policies should allow for greater flexibility in the timing of study and survey efforts and should prioritize providing access during critical times in the life cycle of *L. maximum* and invasive weeds.
- (5) Work with the military to incorporate into the proposed Fire Management Plan an active commitment to use back-fires or other appropriate techniques to prevent wildfires from spreading east of Ridge Road.

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Personal Communications: The following people were contacted for information relevant to the status of *Lithophragma maximum*. These people provided a range of expertise based on their involvement with specific survey efforts, scientific studies, and/or management of Channel Island biological resources:

Ames, Chelsea. Plant Propagator, Rancho Santa Ana Botanic Garden, Claremont, California. August 3 and 9, 2006, electronic mail communications to William B. Miller of the Carlsbad Fish and Wildlife Office.

Dunn, Jonathan. Botanical Conservation Manager at the San Diego Zoological Society Conservation and Research for Endangered Species, Applied Conservation Division, Escondido, California. April 11, 2006, telephone conversation with William Miller of the Carlsbad Fish and Wildlife Office.

Jett, Susan. Director of Horticulture at the Rancho Santa Ana Botanic Garden, Claremont, California. July 28, 2006, telephone conversation with William B. Miller of the Carlsbad Fish and Wildlife Office.

Junak, Steve. Santa Barbara Botanic Garden, Santa Barbara, California. June 19, 2006, telephone conversation with William Miller of the Carlsbad Fish and Wildlife Office.

Kellogg, Elizabeth. Tierra Data Systems, Escondido, California. Consultant to the Department of the Navy. April 21, 2006, and July 5, 2006, telephone conversations with William B. Miller of the Carlsbad Fish and Wildlife Office.

Showers, Mary Ann. Staff Environmental Scientist, Lead Botanist, California Department of Fish and Game, Sacramento, California. August 8, 2006, electronic mail communication to William B. Miller of the Carlsbad Fish and Wildlife Office.

U.S. FISH AND WILDLIFE SERVICE
5-YEAR REVIEW of San Clemente Island Woodland-Star (*Lithophragma maximum*)

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

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

Appropriate Listing/Reclassification Priority Number, if applicable _____

Review Conducted By William B. Miller

FIELD OFFICE APPROVAL:

Lead Field Supervisor, Fish and Wildlife Service

Approve  Date July 31, 2007

REGIONAL OFFICE APPROVAL:

Acting
Lead Regional Director, Fish and Wildlife Service

Approve  Date 8/29/07

Appendix 1 Compilation of Data for <i>Lithophragma maximum</i> Occurrences					
Identification Number/Occurrence	Count	Observer	Source	Year	Comments
1	15	Howard Ferguson	USFWS Listing File	1980	Eagle Canyon
1	12	Howard Ferguson	USFWS Listing File	1981	
1	20	S. Burckhalter	Junak and Wilken 1998	1997	Recorded as population No. 2 in Junak 1996/97 data
2	2	Howard Ferguson	USFWS Listing File	1979	Eagle Canyon
2	0	Howard Ferguson	USFWS Listing File	1980	
2	0	Howard Ferguson	USFWS Listing File	1981	
3	9	Mitchell Beauchamp	USFWS Listing File	1986	Bryce Canyon
3	9	Orlando Mistretta	USFWS Listing File	1989	
4	14-18	Howard Ferguson	USFWS Listing File	1980	Bryce Canyon
4	14-18	Howard Ferguson	USFWS Listing File	1981	
5	7	Steve Junak	Junak 2006	4-21-03	Bryce Canyon Recorded as population No. 0 in Junak 2003/04 data
6	~30	Mark Elvin	Elvin 1996	1996	3 rd Canyon N. of Mosquito Cove, Recorded as population No. 4 in Junak 1996/97 data
7	<20	Steve Boyd	USFWS Listing File	1990	
8	104	Steve Junak	Junak and Wilken 1998	4-23-96	S. Fork of 1 st Canyon N. of "Malo 1", Recorded as population No. 6 in Junak 1996/97 data
9	<20	Steve Boyd	USFWS Listing File	1990	

Identification Number/Occurrence	Count	Observer	Source	Year	Comments
10	75	Steve Junak	Junak and Wilken 1998	10-29-1997	1 st Canyon S. of Camera Pad "Malo", Recorded as population No. 1 in Junak 1996/97 data
11	>75	Mark Elvin	Elvin 1996	1996	
12	96	Steve Junak	Junak and Wilken 1998	3-12-1997	2 nd Canyon S. of Camera Pad "Malo", Recorded as population No. 0 in Junak 1996/97 data
13	4	Steve Boyd	USFWS Listing File	1990	
14	~30	Mark Elvin	Elvin 1996	1996	2 nd Canyon N. of Mosquito Cove, Recorded as population No. 5 in Junak 1996/97 data
15	16	Tim Ross	USFWS Listing File	1991	Same map location as C. Clark 1996
15	>60	C. Clark	USFWS Listing File	1996	Same map location as T. Ross 1991
16	65	Steve Junak	Junak and Wilken 1998	1996	N. fork of Mosquito Cove Canyon, Recorded as population No. 3 in Junak 1996/97 data
17	10	Steve Junak	Junak 2006	5-20-2003	S. fork of Matriarch Canyon, Recorded as population No. 1 in Junak 2003/04 data