RARE PLANTS IN THE GOAT HARBOR BURN AREA, SANTA CATALINA ISLAND, CALIFORNIA

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Abstract—In 1999, the Goat Harbor fire burned approximately 121 hectares of habitat on Santa Catalina Island including scrub oak chaparral, grassland, coastal sage scrub, as well as Catalina ironwood and Catalina cherry groves. An experimental monitoring study initiated by the Catalina Island Conservancy tracked the recovery of island vegetation following fire and investigated the impacts of non-native animals on plant recovery. Of particular interest was the health and regeneration of the endemic Catalina ironwood (*Lyonothamnus floribundus* var. *floribundus*). Early monitoring indicated that basal sprouts were being decimated by deer in the burned groves. Ten groves were then fenced, along with several experimental scrub oak chaparral plots. Monitoring of these groves was combined with point-intercept transects, reconnaissance, and photomonitoring. Numerous rare herbaceous species were found, including a species never recorded before on the island, fire poppy (*Papaver californicum*), and two species recorded only once to two times before: white mallow (*Eremalche exilis*), and large-flowered phacelia (*Phacelia grandiflora*). Six rare or uncommon perennial species, including several island endemics, germinated and flourished within the exclosures yet were particularly susceptible to browsing elsewhere: felt-leaf and bigpod ceanothus (*Ceanothus arboreus* and *C. megacarpus*), chaparral mallow (*Malacothamnus fasciculatus*), Channel Island tree poppy (*Dendromecon harfordii*), the Federally Threatened island rush-rose (*Helianthemum greenei*), and Wallace's nightshade (*Solanum wallacei*). Emphasis in this study was placed on gathering a variety of preliminary information about fire responses by island communities, at the expense of having numerous replicates. The data gathered from this study will provide the knowledge base to guide future, more specific burn studies. The fire and ensuing exclosures have provided an interesting glimpse into what island habitats would be like with a more frequent fire regime and protection from non-native animal browsing.

Keywords: fire, herbivory, Lyonothamnus, post-fire vegetation recovery, rare plants

INTRODUCTION

The historical role of fire on the Channel Islands of California is poorly known. A naturally lower incidence of lightning-ignited wildfires in coastal regions is compounded by the lack of ability for fires to spread across an ocean barrier, as well as by lowered fire ignition in grazed areas (Carroll et al. 1993). Heavy grazing and browsing on Catalina by introduced herbivores such as feral goats (*Capra hircus*) feral pigs (*Sus scrofa*), mule deer (*Odocoileus hemionus californicus*), and American bison (*Bison bison*), have historically reduced the fuel load, likely altering the natural ignition rate and confounding our understanding of natural processes on the island. (Minnich 1982). A fire history currently being compiled for Catalina Island shows four lightning fires igniting within the last 36 years, none of them reaching over 0.4 ha (1 acre) in size.

Scrub communities are recovering with the removal and management of introduced ungulates, and fire management is an increasingly critical issue for the Catalina Island Conservancy. Removal of feral goats and pigs is anticipated to be completed at the end of 2004, and American bison are being managed at a herd size of approximately 150 within the central portion of the island. Other non-native herbivores include the black rat (*Rattus rattus*), house mouse (*Mus musculus*), and Norway rat (*Rattus norvegicus*). The largest native

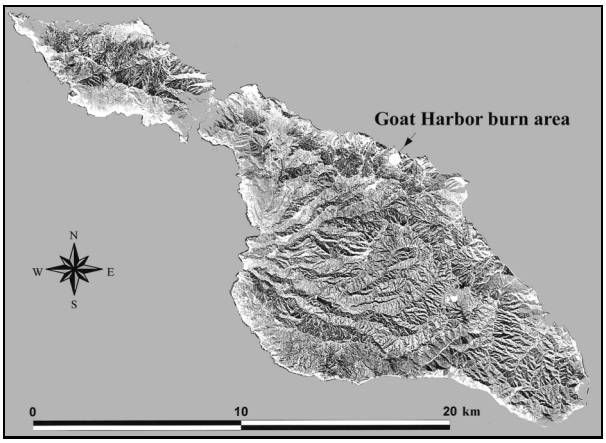

Figure 1. Location of study Goat Harbor burn area on Santa Cruz Island, CA.

herbivore on the island is the Beechey ground squirrel (*Spermophilus beecheyi nesioticus*).

Seeds of the island endemic species Santa Cruz Island manzanita (*Arctostaphylos insularis*) and felt-leaf ceanothus (*Ceanothus arboreus*) collected on Santa Cruz Island appear to respond well to fire treatment, suggesting that they have evolved to withstand periodic fires (Carroll et al. 1993). Currently, rare chaparral types on Catalina dominated by Catalina manzanita (*Arctostaphylos catalinae*), felt-leaf ceanothus, and mission manzanita (*Xylococcus bicolor*) are likely scarce at least partially due to the infrequency of fire on the island (Landis 2000). The historical importance of fire on the Channel Islands and its current role in ecological restoration are important questions facing the Catalina Island Conservancy as well as other island land managers today.

The Goat Harbor fire ignited from an illegal campfire in July of 1999, charring approximately 121 ha of habitat on the north coast of the island (Fig. 1) including scrub oak chaparral, grassland, coastal sage scrub, and both Catalina ironwood and Catalina cherry groves. The Goat Harbor area is not known to have burned within the last century. A vegetation study was initiated by the Ecological Restoration Department of the Catalina Island Conservancy in March of 2000. The goals of this study were to monitor and document the recovery of Catalina Island vegetation following fire, to document the various species that germinate following fire, and to investigate the impacts of non-native animals on plant recovery. Of particular interest was the presence of rare and endemic plant species, the impacts of herbivores on community regeneration, and the health and regeneration of the Catalina ironwood (*Lyonothamnus floribundus* var. *floribundus*), a Catalina endemic species. Of 159 Catalina ironwood groves on the island, fourteen groves were burned in the Goat Harbor fire (Takara 1999). Eleven of these were severely burned, two were moderately burned, and one was lightly burned.

MATERIALS AND METHODS

Post-fire vegetation recovery was monitored using permanent point-intercept transects, photomonitoring, reconnaissance surveys, focused Catalina ironwood grove monitoring, and deer exclosures. Locations of transects, ironwood groves, and exclosures are shown in Fig. 2. A total of 27 permanent point-intercept transects were established in the five plant communities, with nineteen of these in burned habitat, seven outside the burn perimeter, and one located in an unburned area within the burn perimeter. A 30- x 5-m belt was added to each transect to provide species richness information by documenting any plant species not noted on the transect.

Emphasis in this study was placed on gathering a breadth of preliminary information about fire responses by Catalina plant communities, focusing on the dominant plant communities within the burn area and on the island. Due to time and resource limitations, this was at the expense of having numerous replicates within each of the five plant communities present. The number of transects for each plant community inside and outside the burn are as follows: eight scrub oak chaparral inside and two outside; six grassland inside and two outside; two coastal sage scrub inside and one outside; two Catalina ironwood groves inside and two unburned groves (one inside and one outside the burn boundary); one Catalina cherry woodland inside and one outside.

The location of each of the transects was determined using a stratified random selection process based on plant community and fire intensity (light, moderate, severe, and unburned). For each plant community type, aspect was standardized to within the 90 degrees (primarily north-facing), with the exception of ironwood

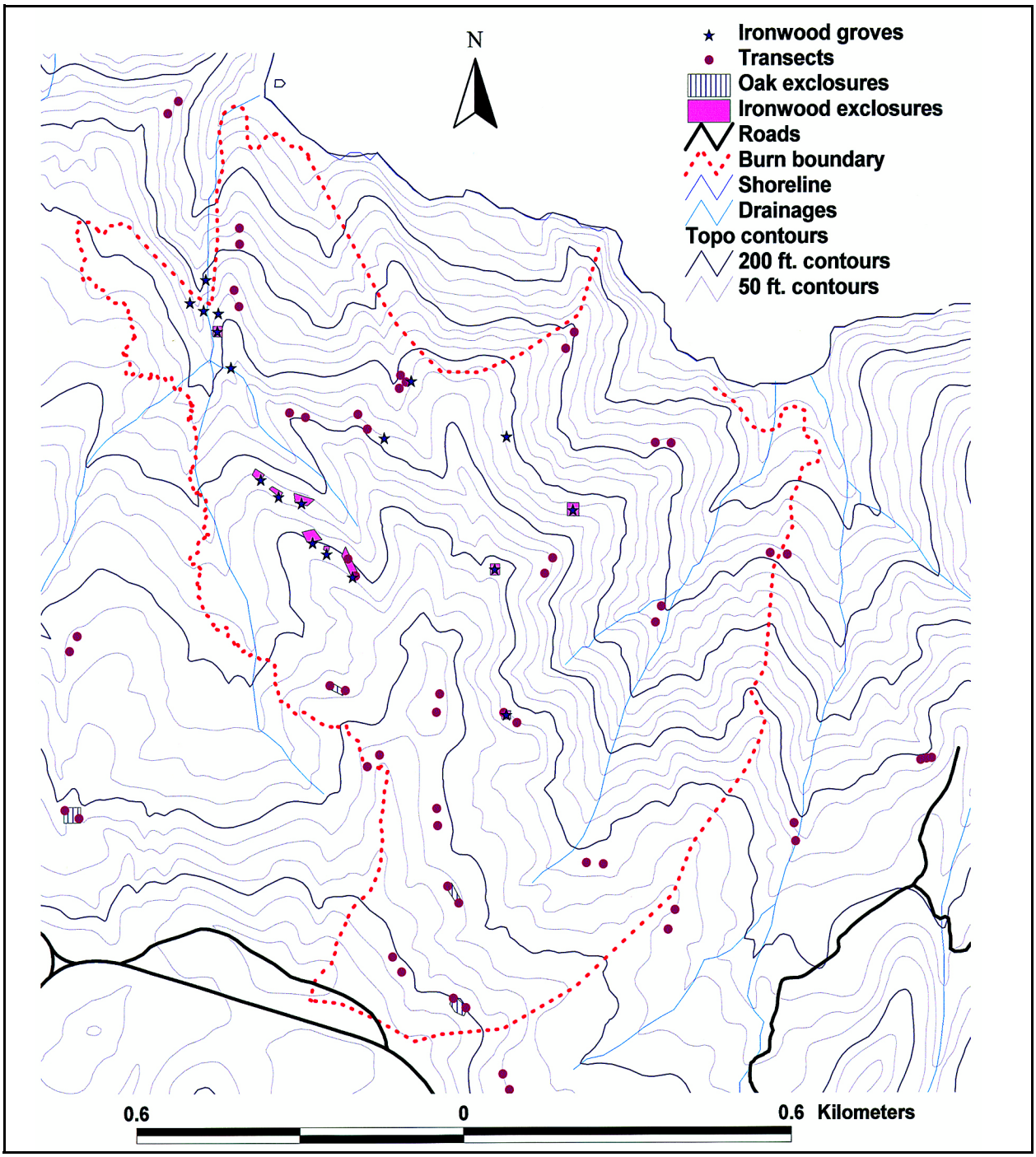

Figure 2. Goat Harbor burn area.

groves. The slope of each transect was between 16 and 36 degrees, and transects were read between the months of April and June. Point-intercept transects associated with eighty land bird monitoring points located throughout the island provide additional data for comparison of burned with unburned areas (Knapp unpubl. data). All eighty land bird monitoring transects were read in 2001, while a subset (approximately half) of them was read in 2002 and 2003.

Two small ironwood groves were fenced shortly after the burn in fall of 1999 to investigate the impacts of browsing animals on post-fire recovery. Monitoring in January of 2000 indicated

that basal sprouts were being decimated by mule deer in the twelve unfenced groves, while those that were fenced were sprouting vigorously. Six additional groves at the greatest risk of browsing impact were fenced throughout the next year. Monitoring of each of the burned groves was conducted one to two times yearly between 2000 and 2002 (February 2000, July 2000, February 2001, August 2001, and February 2002). Attributes recorded include the number of trees with sprouts less than 0.3 m (1 ft) high vs. sprouts over 0.3 m (1 ft) high, maximum sprout height per grove, and general vigor. Our management goal was to save each of the groves from extirpation, thus maintaining the current number of ironwood groves within the Goat Harbor Burn area.

Two exclosures were constructed surrounding scrub oak chaparral transects in spring of 2000, in order to investigate the impact that introduced herbivores may have on the resprouting of island scrub oak (*Quercus pacifica*) and associated plants. Two additional scrub oak chaparral exclosures were constructed surrounding existing transects in 2001; one within the burn and one outside of the burn.

RESULTS

Catalina Ironwood Groves

In order to protect the trees that needed it the most, the groves that we selected for fencing had the lowest proportion of healthy sprouts initially, while those we chose not to fence were in the best health, therefore biasing the results. Data on the percentage of sprouts greater than 0.3 m (1 ft) tall per grove show dramatic growth for fenced groves the first year; unfenced groves showed a slight decline (Fig. 3). Those groves that were fenced in 2000 showed more improvement than those that were fenced in 2001. Basal sprouts grew quickly when protected; February 2001 ironwood monitoring revealed sprouts to 3.4 m (11 ft) high in the fenced groves, while the unfenced trees were still struggling (mean 23% of all sprouts less than 0.3 m tall). Two of the unfenced groves were subsequently protected from deer in 2001, and their status improved.

Maximum sprout height, compared using an Analysis of Variance (ANOVA), differed significantly between fenced and unfenced groves in February of 2001 ($P = 0.04$, $F = 5.3$) and in February of 2002 ($P = 0.007$, $F = 11.1$), based on fencing status in February 2001). In general, the vigor of the groves fenced right after the burn in 1999 started and remained high, those groves which were fenced in 2000 and 2001 improved markedly in vigor following fencing, and the four groves which remain unfenced varied in vigor. One of the unfenced groves is still in poor health, while three have grown past browse height and are doing well.

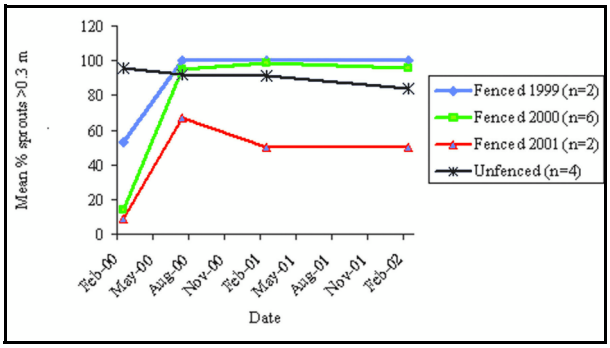

Figure 3. Percent ironwood sprouts >0.3 m (1 ft.) tall per grove by date and fencing status.

Rare Herbaceous Species

Reconnaissance surveys and transects revealed several rare herbaceous species which germinated as a result of the burn, including a species never recorded on the island, (fire poppy [*Papaver californicum*]), a species recorded only once before (white mallow [*Eremalche exilis*]), and a species recorded only twice before (large-flowered phacelia [*Phacelia grandiflora*]). Transect data (Table 1) comparing the burned area with areas outside the burn boundary (Goat Harbor Burn and Land Bird Monitoring projects) shows the marked difference in presence/absence of these and other rare herbaceous species, illustrating the importance of fire in these communities. An ANOVA shows this difference to be significant ($P = 0.01$, $F = 10.2$).

Rare Perennial Species

Six rare or uncommon perennial species, including several endemics, germinated following the burn. These species flourished when protected within the exclosures, yet were particularly susceptible to browsing elsewhere. They include felt-leaf and bigpod ceanothus (*Ceanothus arboreus* and *C. megacarpus*), chaparral mallow

Table 1. Transects with rare and endemic herbaceous species in burned vs. unburned areas, 2000–2003.

		Burned	Unburned	
Species	Status[1]	# transects GHBurnIn (n = 19)	# transects GHBurnOut (n = 8)	# transects island-wide (n = 80)
Athysanus pusillus	ThorneRare	2 (11%)	0	0
Gilia nevinii	CNPS 4, IslEndemic RESMAP	3 (16%)	0	0
Papaver californicum	NewRare	3 (16%)	0	0
Phacelia grandiflora	ThorneRare	1 (21%)	0	0
Trifolium microdon	former IslEndemic, ThorneRare	2 (11%)	0	2 (3%)
Vulpia microstachys	ThorneRare	8 (42%)	1 (13%)	11 (14%)

[1]Key:
CNPS 4 = Plants of Limited Distribution: a watch list (California Native Plant Society).
IslEndemic = Islands endemic (including Guadalupe and San Martin Islands, Mexico).
NewRare = First time recorded on Catalina Island.
RESMAP = Rare and Ecologically Sensitive Mapping Project, Catalina Island Conservancy.
ThorneRare = Per Thorne's flora (1967), fewer than 3 localities/collections, often very restricted.
GHBurnIn = Within the Goat Harbor Burn Area.
GHBurnOut = In the vicinity of the Goat Harbor Burn Area, outside the burn boundaries.

(*Malacothamnus fasciculatus*), Channel Island tree poppy (*Dendromecon harfordii*), island rush-rose (*Helianthemum greenei*), and Wallace's nightshade (*Solanum wallacei*). Several of these species (*Ceanothus* spp., *Malacothamnus fasciculatus*), or their closely related mainland counterparts (*Dendromecon rigida*) are known to have refractory seeds which are stimulated to germinate by fire (Keeley 1991). Transect data presented in Table 2 shows that four of these species were found on multiple transects within the burn, yet were not found on any of the transects outside of the burn. *C. megacarpus* and *S. wallacei*, although noted in the area, were not directly on any of the transects. Judging by the number of rare perennial species inside the exclosures constructed in the spring of 2000 compared to the ones constructed the following year, it seems critical that exclosures be constructed as soon as possible following fire to protect these plants. Each of the six species is addressed below.

Island rush-rose—This plant is Federally listed as a Threatened species, and is rare on Catalina. It appears to be stimulated by fire, as found on Santa Cruz Island (Schuyler pers. comm.), and has been found in three locations within the Goat Harbor Burn area. One of these populations, within an exclosure, was healthy and flowering by the second year. The two other populations were unfenced; one disappeared by the second year and the other survives in a depauperate, vegetative state.

Wallace's nightshade—This subshrub was formerly considered a Catalina endemic (var. *wallacei*, Thorne 1967); because its variety status was dropped in the most recent flora (Hickman), it is now considered an island endemic. Its large, soft leaves make it an attractive browse plant. This species persisted in one ironwood exclosure, but was not found to germinate and survive elsewhere in the burn.

Felt-leaf ceanothus—This Channel Islands' endemic is occasionally found as isolated individuals throughout the island, and in rare cases may dominate the Island Chaparral community. This species germinated in abundance throughout the burn, forming a dense thicket inside one ironwood exclosure. It has grown much taller (by up to ~1.5 m) in the exclosures than outside, and has shown better survival there (pers. observ.). It was extirpated from one out of four of the unfenced transects it was originally found on, and persisted on one fenced transect.

Bigpod ceanothus—This species was only found in one location within the burn area, inside a scrub oak exclosure. Several seedlings are growing there, yet no mature trees have been found within the burn boundary.

Channel Island tree poppy—Multiple individuals of this shrub, a Channel Islands endemic, survived within two ironwood exclosures and one oak exclosure. The seedlings of this plant found outside the exclosures disappeared by the second year. Mule deer have knocked down or otherwise found their way into two of these exclosures, and severely browsed the tree poppy plants inside.

Chaparral mallow—Formerly classified as ssp. *catalinensis* (Thorne 1967), which is found on Catalina and in the Santa Monica Mountains, this plant is currently combined with other subspecies in a California-wide distribution (Hickman 1993). It forms scattered small populations on the island. Seedlings of this species were prolific in the burn area. Out of six unfenced transects, this species was found on three, but disappeared in two of those after the first year. It was also found on one fenced transect, where it persisted. This fenced individual is much taller (~1.2 m) than the unfenced plants, which still struggle at ankle height against browsing animals.

DISCUSSION

The preliminary data presented here suggest that fire is an important factor in the germination of many rare or uncommon herbaceous and perennial species on Catalina Island. The Goat Harbor fire and resulting exclosures have provided a glimpse into what Santa Catalina Island habitats would be like with a more frequent fire regime and protection from non-native animal browsing: very likely a number of perennial species which are currrently rare or uncommon on the island would be much more common. For short-term management, rare resprouting species such as the Catalina ironwood may require protection from introduced herbivores in order to successfully recover from a burn. Seedlings of some rare perennial species stimulated by fire may need protection from non-native animals in order to survive at all, while others may be prolific enough to ensure their continued existence despite stunting and attrition due to browsing. Results for both ironwood groves and rare perennial or herbaceous species suggest that exclosures should be built within the first year following fire for the most effective protection of these plants.

Despite small sample sizes and the ad hoc nature of our exclosure construction, the data gathered from this study have provided information about fire effects that will guide ecological management and future burn studies. Following a new fire which burned over 100 acres of island chaparral/coastal sage scrub habitat near the Airport in January of 2003, we installed three exclosures simultaneously, prior to the first rains, in order to provide more standardized experimental data on the effects of browsing animals on post-fire recovery.

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